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PATENT & TRADEMARK OFFICE

IN THE UNITED STATES PATENT AND TRADEMARK OFFICE

In the Application of Embil *et al.*	: Group Art Unit 1615 : Examiner Channavajjala
Serial No.: 10/761,390	:
For: Topical Pharmaceutical and/or Cosmetic Dispense Systems	:
Filed: January 22, 2002	:
Commissioner for Patents P.O. Box 1450 Alexandria, VA 22313-1450	:

DECLARATION UNDER 37 C.F.R. § 1.131

I, Robert Y. Lochhead, being duly sworn depose and say:

1. I have prepared this declaration so that in may be considered by the US Patent and Trademark Office in connection with Patent Application Serial No. 10/761,390 ("the '390 Appln".)

2. I received a Bachelor of Science degree in Chemistry with honors and a Doctor of Philosophy degree in Chemistry, both from the University of Strathclyde, Glasgow, Scotland. Thereafter, I conducted post-doctoral research as a Fulbright-Hayes Senior Scholar at Carnegie Mellon University.

3. I have over 35 years of industry and academic experience in polymer science, including 8 years as a scientist/manager with Unilever Research in London, England; 11 years with The B.F.Goodrich Company in Avon Lake, Ohio and Brecksville, Ohio, during which time I served as Manager of Hydrophilic Polymers Research and Development Department; and for the past 17 years as a faculty member of the Department of Polymer Science of the University of Southern Mississippi ("USM"). During my academic tenure at USM, I have been Chair of the Department

of Polymer Science, Director of the School of Polymers and High Performance Materials, and Dean of the College of Science and Technology. I have served as President of the US Society of Cosmetic Chemists and also as President of the Association of Formulation Chemists. I am a Fellow of both the Royal Society of Chemistry and the Society of Cosmetic Chemists. My professional experience is further reflected in the attached curriculum vitae.

4. In preparing this Declaration, I have reviewed Application Serial Number 10/761,390, the Non-Final Office Action dated April 9, 2007, including the following prior art documents cited therein, the teachings of which form the basis for rejecting the claims of the '390 Appln. as obvious under 35 U.S.C. § 103(a): US Patent No. 6,106,812 ("Prencipe"); US Patent No. 5,510,116 ("Froix"); international patent application WO 9315726 ("WO26"); European Patent Application EP 306236 ("EP236"); and the article by Wester *et. al.* in *J. Am. Acad. Derm.* Vol. 24, No. 6, pp. 720-726, (May, 1991)("Wester").

5. The '390 Appln. teaches treatment of dermatological and cosmetic conditions by topical application of two active ingredient-containing water-based formulations which are maintained separately (*e.g.*, in a dual chamber container) until dispensed and characterized where (i) at least one of the formulations contains active ingredients in a polymeric delivery system and (ii) both of the formulations comprise water-based carrier bases having substantially the same lipophilicity. As discussed further below, neither of the primary references relied upon in forming the 103(a) rejection – Prencipe or WO26 – teach or suggest formulations comprising polymeric delivery systems. Moreover, none of Prencipe, Froix, EP236, Wester or WO26 teaches or suggests topical application of two formulations comprising water-based carrier bases having substantially the same lipophilicity.

Problem Solved By the Present Invention – Incompatibility of Actives

6. One aspect of the invention claimed in the '390 Appln. is directed to treatment of dermatological conditions by topical application of a composition containing two otherwise incompatible active ingredients – oxidizing antibacterials (including, in particular, benzoyl peroxide) and antibiotics (including, in particular, clindamycin). These ingredients are "incompatible" in the same formulation because strong oxidizing agents react with antibiotics, leading to the loss of potency of both actives. For this reason, oxidation limits the useful shelf life of a topical product in which the two ingredients are combined. Prior art solutions to this problem are disclosed in the '390 Appln. One such approach, taught in US Patent No. 6,462,025, discloses separation of antibiotic and benzoyl peroxide compositions, both in substantially anhydrous formulations, until immediately prior to application to the skin. In contrast, each of the active ingredient-containing formulations that are combined on the skin are hydrous – containing in excess of 5%, 10%, 20%, 30% or 40% by weight of the final (admixed) topical product.

Polymeric Delivery System

7. A first essential element of the invention claimed in the pending application is a polymeric delivery system which must be present in at least one of the two component formulations that are combined into a final topical dermatologic or cosmetic product.

8. A person having ordinary skill in the art would understand that all polymers are not polymeric delivery systems, particularly in light of Paragraph [0050] of the '390 Appln. which defines polymeric delivery system as polymer particles (*e.g.*, microparticles) as well as aggregates or agglomerates (*e.g.*, clusters) of such particles that are capable of entrapping a desired active ingredient for delayed release. This paragraph of the application further describes

these polymer particles as generally porous and typically cross-linked. The following paragraphs [0051] – [0054] describe three specific types of polymeric delivery systems sold under the tradenames Poly-Pore®, Poly-Trap® and Microsponge®.

9. Claims 1, 2, 4 – 7, and 23 – 24 are rejected in the Office Action as being obvious in light of the teaching of Table 1 of Prencipe which discloses a paste and gel that are stored separately in a compartmented dispensing container having collapsible sidewalls (*e.g.*, a tube) and combined as a single toothpaste when dispensed (*e.g.*, upon squeezing the tube). Based on the disclosure of Prencipe, the active ingredients in the formulations of Table 1 would be understood as follows: Paste A-1 contains as active ingredients tetrasodium pyrophosphate and sodium tripolyphosphate, both of which act as tartar control agents. *See*, Prencipe, Col. 4, line 4 – Col. 5, line 6. Paste A-2 contains as an active ingredient Triclosan, which reduces gingival inflammation. *See also* "Whitening Toothpastes" *J. Amer. Dental. Assoc.* Vol. 132, pp. 1146 - 1147 (August 2001)(copy attached). The gel formulations contain hydrogen peroxide as a bleaching active ingredient. As discussed immediately below, none of these active ingredients are taught or suggested to be encapsulated, entrapped or otherwise incorporated in a polymeric delivery system.

10. While the Office Action does not specifically identify polymers taught in Table 1 of Prencipe, I recognize the following polymers as being taught by Prencipe: carboxyvinyl polymers, carboxymethylcellulose, and anionic carboxylates such as copolymers of maleic anhydride or maleic aid with methyl vinyl ether, ethyl acrylate, hydroxyethylmethacrylate, N-vinyl-2- pyrrolidone, or ethylene. *See* Prencipe, Col. 3, lines 26 – 45. Three of the gel compositions in Table 1 of Prencipe (Gels B, D and E) contain Carbopol 974P. (Carbopol® is the commercial name for a family of carboxyvinyl polymers. (Prencipe, Col. 3, lines 34 – 36.)

Two of the pastes in Table 1 of Prencipe contain carboxymethylcellulose ("CMC"), a natural cellulosic polymer. A person having ordinary skill in the pertinent art would recognize Carbopol and CMC to be thickeners for aqueous or hydric solvent systems. A person having ordinary skill in the art would also understand and recognize that these polymers are not, nor do they function as, a polymeric delivery system of the type claimed in the '390 Appln.

11. The Office Action similarly rejects the same claims as obvious under 35 USC §103(a) based on the teaching in WO26 of "a composition for acne treatment comprising clindamycin and benzoyl peroxide in the form of a kit, separately maintained in different containers ... [wherein the] benzoyl peroxide composition comprises a polymer and both compositions have water and hence meet the claimed limitations." While the benzoyl peroxide composition taught in WO26 does comprise a polymer, a person of ordinary skill would understand that not all "polymers" are "polymeric delivery systems". The specific polymers taught in WO26 are carboxy vinyl polymers, "preferably carboxymethylene which is commercially available under the tradename Carbopol®." *See*, WO26 Page 6, Lines 21-23. *See also,* WO26, Page 12, Examples 5 – 9. As discussed in Paragraph 10 of this Declaration, carboxy vinyl polymer is a thickener and is not a polymeric delivery system as claimed in the pending application.

Substantially the Same Lipophilicity

12. The Office Action rejects the claims 1, 2, 4 – 7, and 23 – 24 as obvious under 35 USC §103(a) in light of the teachings of Prencipe as well as the teachings of WO26. However, neither of these two references teaches or suggests a second essential claim element of the invention claimed in the pending application – namely that the two component active ingredient-containing formulations each have "substantially the same lipophilicity". This required claim

element is necessary to ensure consistent release of the active ingredient from the polymeric delivery systems. *See*, '390 Appln. Col. 2, Paragraph [0018].

13. The '390 Appln. teaches that lipophilicity may be tested by determining the partition coefficient in respect of each carrier base. Partition coefficient is determined, in large measure, by solubility. More specifically, in the context of the pending application, lipophilicity is the partition coefficient of the active ingredient in the polymeric delivery system relative to the carrier base. As explained in Paragraph [0018] of the '390 Appln., the degree of lipophilicity affects the partition coefficient of active ingredient between the polymeric delivery system particles (in which the active ingredient is loaded) and the carrier.

14. Partition coefficient thus controls the rate of release of active ingredient into the carrier and to the skin. This is further illustrated at Col. 5, Paragraph [0057] of the '390 Appln. with respect to a formulation containing an antibacterial or keratolytic agent entrapped in a polymeric delivery system. According to the disclosure of Paragraph [0057], the rate at which the active agent (*i.e.*, antibacterial or keratolytic) is released by diffusion from the polymeric delivery system depends on the partition coefficient between the polymeric delivery system and the carrier. Thus, if the active ingredient entrapped or impregnated in a polymeric delivery system, is highly soluble in the carrier, the polymeric delivery system will "dump" the active earlier than is desired. Similarly, if the solubility of the carrier is lower than desired, delivery can be retarded, diminishing the efficacy of the product. This is further illustrated specifically with respect to the invention claimed in the '390 Appln. in the following example:

- Composition I (containing an active ingredient entrapped in a microsponge) and Composition II are dispensed from a dual-chamber container and admixed on the skin.

- Where the active ingredient in the microsponge has greater solubility in the carrier of Composition II, mixing of Compositions I and II could result in dumping of the active. In the case of certain actives, this could result in too high a dose and possible adverse health effect.
- In contrast, where the active ingredient in the microsponge has lesser solubility in the carrier of Composition II, the rate of delivery of the active from the microsponge could be impeded when Compositions I and II are mixed, resulting in a less efficacious product.

15. As a further example of the importance of lipophilicity, the case of benzoyl peroxide an active ingredient specifically claimed in the '390 Appln – is instructive. Benzoyl peroxide has very low solubility in water. Addition of hydric materials to a water-based carrier such as polyethylene glycol (PEG), propylene glycol, ethanol, and glycerin can change the solubility of benzoyl peroxide by orders of magnitude. *See, e.g.*, Table I (reproduced below) from "Benzoyl Peroxide Solubility and Stability in Hydric Solvents", *Pharmaceutical Research*, Vol. 9, No. 10, 1992, pages 1341 to 1346. A complete copy of this article is attached as Exhibit A.

Table I. Solubility of Benzoyl Peroxide in Various Solvents

Solvent	Solubility (mg/g) determination 1	Solubility (mg/g) determination 2	Dielectric constant
PEG 400	39.6	40.0	14.4
PEG 400/water			
9:1	15.9	12.5	23.0
8:2	2.47	2.51	30.3
7:3	1.30	1.70	36.9
6:4	0.288	0.388	43.2
5:5	0.127	0.129	48.2
4:6	0.0377	0.0377	55.8
3:7	0.0124	0.0124	60.2
2:8	0.00325	0.00329	62.2
1:9	0.000528	0.000628	69.2
PEG 400/propylene glycol (6:4)	19.2	16.0	19.9
Ethanol	17.9	17.7	24.9
Ethanol/water (1:1)	0.77	0.76	46.5
Propylene glycol	2.95	2.95	28.3
Propylene glycol/water (75:25)	0.36	0.37	43.5
Glycerine	0.15	0.15	42.5[a]
Water	0.000155[b]		78.5[a]

[a] Value obtained from NBS circular 514.
[b] Extrapolated estimate.

16. From the above table, the solubility of benzoyl peroxide in water is 0.000155 mg/g, whereas the solubility of benzoyl peroxide in PEG 400 is 39.6 or 40mg/g. The difference in benzoyl peroxide's solubility between these two solvents is, therefore, about 25 million percent. Using the data in Column 1 of Table 1, I have tabulated the percent change in solubility for each of the solvents or solvent mixtures in Table 2 below.

Table 2: Percent difference in solubility of benzoyl peroxide (BPO) as a function of solvent type

Solvent	BPO Solubility (mg/g)	% Difference from BPO Solubility in Water
Water	0.000155	0
PEG 400	39.6	25,548,287
PEG 400 : water		
9 : 1	15.9	10,257,965
8 :2	2.47	1,593,448
7 : 3	1.3	838,610
6 : 4	0.288	185,706
5 : 5	0.127	81,835
4 : 6	0.0377	24,223
3 : 7	0.0124	7,900
2 : 8	0.00325	1,997
1 : 9	0.000528	241
PEG 400 : propylene glycol (6:4 ratio)	19.2	12,386,997
Ethanol	17.9	11,548,287
Ethanol/water (1:1)	0.77	496,674
Propylene glycol	2.95	1,903,126
Propylene glycol/water (75:25)	0.36	232,158
Glycerin	0.15	96,674

17. Benzoyl peroxide is more than 25 million percent more soluble in PEG 400 than in water. The mere addition of 10 percent PEG 400 to water increases the solubility of benzoyl peroxide by 241%. Similarly, benzoyl peroxide is almost 500,000 percent more soluble in a 1:1 mixture of ethanol to water than in water. By way of further comparison, benzoyl peroxide is almost one quarter of a million percent more soluble in a mixture of propylene glycol and water when mixed in a ratio of 75 : 25.

18. Table 1 of Prencipe teaches the combination of Paste A-1 with Gel B. Paste A-1 contains 12% glycerin, 22.6% sorbitol, and 10.3% water. Gel B contains 40% glycerin, 10% PEG, and 39.9% water. Based on the data, calculations and discussion in Paragraphs 15 – 17 of my Declaration, these two compositions would not possess "substantially the same lipophilicity" as it is defined in the '390 Appln.

19. Replacement of sorbitol by polyethylene glycol will result in different partitioning of ingredients and, as a consequence, different lipophilicities of the aqueous carrier bases.

20. As discussed above, there is no teaching in Prencipe to match the lipophilicity of the two formulations to be substantially the same. Moreover, because there is no teaching or suggestion of a polymeric delivery system in Prencipe, the person having ordinary skill in the art would have no motivation to modify the formulations taught by Prencipe to have substantially the same lipophilicity.

21. The example compositions on pages 11 and 12 of WO26 are combined in Examples 10 through 13 on pages 13 and 14 of that reference. In Example 10 (WO26 at page 13) the clindamycin solution of Example 1 is combined with the benzoyl peroxide suspension of Example 5. The solution of Example 1 is taught to have a pH of 6.2 and to contain 89.3% by weight of water. The suspension of Example 5 is taught to have a pH of 4.5 and to contain 11.56% propylene glycol and 78% water. Based on the data and calculations in Paragraphs 15 and 16 of my Declaration, these two compositions would not display "substantially the same lipophilicity" as defined by the specification and claimed in the pending application.

22. In Example 11 (WO26, pages 13 – 14), the clindamycin solution of Example 1 is combined with the benzoyl peroxide suspension of Example 6. The solution of Example 1 has a pH of 6.2 and contains 89.3% by weight of water. The Example 6 suspension has a pH of 4.3

and contains 7.5 weight % of propylene glycol and about 73 weight % of water. Based on the data and calculations in Paragraphs 15 and 16 of my Declaration, these two compositions would not display "substantially the same lipophilicity" as it is defined by the specification and claimed in the pending application.

23. In Example 12 (WO26, page 14), the clindamycin solution of Example 2 is combined with the benzoyl peroxide suspension of Example 6. The solution of Example 1 has a pH of 4.5 and contains 97.5% by weight of water. The Example 6 suspension has a pH of 4.3 and contains 7.5 weight % of propylene glycol and about 73 weight % of water. Based on the data and calculations in Paragraphs 15 and 16 of my Declaration, these two compositions would not display the "substantially the same lipophilicity" as it is defined by the specification and claimed in the pending application.

24. There is <u>no</u> teaching or suggestion in WO26 to match the lipophilicity of two formulations. Moreover, because WO26 does not teach or suggest formulations containing a polymeric delivery system, a person having ordinary skill in the art would have no motivation to match the lipophilicity of these two component formulations (*e.g.*, to achieve a desired rate of diffusion of the entrapped active ingredient from the polymeric delivery system to the carrier.)

<u>Pertinent Art is Cosmetic/Dermatologic Formulations Not Oral Care Compositions</u>

25. Prencipe discloses a dual component tooth whitening composition containing a peroxide whitening compound and a second ingredient incompatible with the peroxide compound, each being incorporated in separate dentifrice components which are physically separated until dispensed for use. A person having ordinary skill in the art would not use a tooth-whitening composition for the treatment of skin conditions or disorders.

Substantially the Same Water Content

26. Claim 23 of the '390 Appln. claims a topical product comprised of a first and second formulation, each having substantially the same water content. The water contents of Prencipe's examples in Table 1 are substantially different as summarized below:

	Paste A-1	Paste A-2	Gel B	Gel C	Gel D	Gel E
Water Content	89.3	89.7	60.2	69.1	57.8	49.9

The respective paste and gel components would not have substantially the same water content, but also, as discussed above, different lipophilicities.

Substantially the Same Viscosity

27. Claim 24 of the '390 Appln. requires that two active ingredient-containing formulations have substantially the same viscosity. WO26 teaches that the viscosity of a benzoyl peroxide (BPO) formulation is usually from 50,000 – 90,000 cps, more preferably from 65,000 to 85,000 cps, and that a final topical composition (BPO + clindamycin) has a viscosity of 70,000 to 120,000 cps, preferably from 80,000 to 100,000 cps. *See* WO 26, page 8, lines 23-30. While WO26 does not teach the viscosity of the clindamycin-containing solution, I note that Examples 1 – 4 (WO26, page 11) do not contain any thickener, but do contain 85 to 97 percent water. Accordingly, these clindamycin solutions would possess a substantially lower viscosity than the benzoyl peroxide suspensions of Examples 5 – 9. I estimate that the clindamycin solutions of Examples 1 – 4 would have viscosities of less than 100 cps.

Secondary References

28. The Office Action rejects claims 4, 8-22 and 24-28 of the patent application under 35 USC 103(a) as being unpatentable over WO26 in view of two secondary references, Wester and EP36.

30. As discussed above, WO26 does <u>not</u> teach or suggest either of the following: (i) a final topical composition comprised of two separate water-based formulations each comprising water-based carrier bases having substantially the same lipophilicity; or (ii) formulations containing active ingredient(s) in polymeric delivery system(s). In addition, the teachings of WO26 would not motivate a person have skill in the pertinent art to combine two formulations comprising water-based carrier bases having substantially the same lipophilicity.

31. The Wester article describes controlled release of benzoyl peroxide from a polymeric delivery system of the type disclosed in the pending application. However, this study does not include a second formulation to be mixed with the benzoyl peroxide formulation. Wester describes the formulations used only in the briefest terms. Indeed, the detailed chemical composition of the carriers is ignored in this article. While the nature, type and concentrations of excipients in the carrier base are not considered in this academic research article, a person having ordinary skill in the art would understand that the choice of excipients such as thickeners, solvents, humectants or other auxiliary ingredients would affect the aesthetic attributes and performance of a topical composition.

32. Wester does not teach or suggest controlling lipophilicity or matching lipophilicity. This is not surprising, because in the absence of a second formulation, there is little need to match lipophilicity. (Indeed, as discussed above, there is no other formulation on which to conduct a lipophilicity matching exercise.)

33. EP236 likewise teaches a single formulation containing a polymeric delivery system – specifically, solid particles containing a substantially continuous non-collapsible network of pores open the exterior of the particles where the particles are impregnated with an active ingredient. With respect to the carrier, the disclosure of EP236 is limited, teaching a

counterirritant compound in a solvent substantially immiscible with water or a solvent at least partially miscible with water. *See* EP236, Page 31, Claim 8. EP236 does not teach or suggest matching lipophilicity between two formulations.

Further Declarant says not.

I declare further that all statements made herein of my own knowledge are true and that all statements made on information and belief are believed to be true; and further that all statements were made with the knowledge that willful false statements and the like so made are punishable by fine or imprisonment, or both, under Section 1001 of Title 18 of the United States Code, and that such willful false statements may jeopardize the validity of the application or any patents issuing thereon.

Dated: October 5, 2007

By: Robert Y. Lochhead

Robert Y. Lochhead Ph.D. FRSC

Benzoyl Peroxide Solubility and Stability in Hydric Solvents

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Saturated solubility and reaction rate constants for the decomposition of benzoyl peroxide in solution and suspension were determined for use in formulation development. The solvents studied included ethanol, propylene glycol, and cosolvent mixtures of PEG 400 and water. The solubility of benzoyl peroxide was inversely related to the solvent polarity, with greater solubility occurring with semipolar solvents. The stability of benzoyl peroxide in solution was dependent on the solvent, concentration of benzoyl peroxide, and temperature. The compound was least stable in PEG 400. Stability was improved when water was added to PEG 400. Similar solvent effects were observed in suspension. In benzoyl peroxide suspensions of PEG 400 and PEG 400/water blends, benzoyl peroxide stability was dependent on solubility, with improved stability occurring in blends where the benzoyl peroxide was least soluble. Thus, solution formulations of benzoyl peroxide in pharmaceutically acceptable solvents are unlikely to show good stability; however, suspension formulations should be reasonably stable if the vehicle is selected to provide low benzoyl peroxide solubility.

KEY WORDS: benzoyl peroxide; free radicals; stability, kinetics; preformulation.

INTRODUCTION

Benzoyl peroxide (BP) is commonly used in topical formulations for the treatment of acne and, more recently, athlete's foot. Benzoyl peroxide is available as a lotion, cream, gel, cleanser, liquid, bar, or mask at concentrations of 2.5, 5.0, or 10% (1). These formulations may contain water, propylene glycol, isopropyl myristate, acetone, or alcohol in the product vehicle. The chemical instability of benzoyl peroxide makes formulating such products difficult.

Benzoyl peroxide is extremely reactive and degrades in solution at low temperatures (<40°C), because of the instability of the O–O bond, which has a bond energy of approximately 30 kcal/mol (2), compared to 83 kcal/mol for a C–C bond. The degradation of benzoyl peroxide in solution proceeds through a free radical mechanism (3–7). The benzoyl peroxide degradation pathway is shown in Scheme I. Benzoyl peroxide degrades thermally to form benzoate-derived radicals, in the initiation step. These benzoate radicals can propagate the reaction by reacting either with benzoyl peroxide or with solvent to form solvent radicals and other benzoate radicals which react with benzoyl peroxide. The number of propagation reactions per initiation reaction determines the chain length. The reaction is terminated when two radicals couple together. Depending upon the steps chosen, such a scheme can lead to a variety of kinetics. A chain involving only peroxide (reactions 1, 2, and 5) introduces a three-halves-order term in the kinetics, whereas chains involving solvent (reactions 1, 3, and 4) give one-half-, first-, or three-halves-order kinetics, depending upon whether termination is by reaction 5, 6, or 7, respectively (2,6,8).

The stability of benzoyl peroxide in pharmaceutical formulations depends in part on the solvents employed (9). Bollinger *et al.* examined the effects of solvents and surfactants in water on the stability of 10% benzoyl peroxide gel formulations (9). The formulations prepared with alcohol (40%) were less stable, with a loss of 50% following 90 days at 40°C, compared to a 20% loss in laureth 4 (6%) and a 10% loss in propylene glycol (5%). There was no measurable loss of benzoyl peroxide in formulations containing acetone (10%).

Limited kinetic data exist regarding the effects of pharmaceutical solvents on the stability of benzoyl peroxide. The objective of this investigation was to determine the saturation solubility of benzoyl peroxide and the rates of degradation, in solution and suspension, of cosolvent mixtures of polyethylene glycol (PEG 400) and polyols. The solvents were selected to represent a wide range of polarity. PEG 400 was chosen because it is noncomedonegenic and less irritating than smaller-chain polyols.

MATERIALS AND METHODS

Chemical and Reagents. Polyethylene glycol 400 (NF grade) was obtained from Rueger Chemical Co. (Irvington, NJ); propylene glycol from Rueger Chemical Co.; acetonitrile (HPLC grade), methylene chloride (HPLC grade), and methanol (HPLC grade) from J. T. Baker (Phillipsburg, NJ); glycerol (ACS grade) and *o*-phosphoric acid (85%, ACS grade) from Fisher Scientific (Fair Lawn, NJ); benzoic acid (NF grade) from Rueger Chemical Co. (Irvington, NJ); ethanol, 200 proof (USP grade), from Quantum Chemical Corporation (Tuscola, IL); benzoyl peroxide (>97% pure) from Aldrich Chemical Co. (Milwaukee, WI); and purified water (USP grade) from Sterling Research Group (Rensselaer, NY).

High-Performance Liquid Chromatography. The HPLC system consisted of a Waters 510 solvent delivery system (Waters Associates, Milford, MA), equipped with a single-wavelength detector (Spectroflow 757 Absorbance Detector, ABI Analytical, Ramsey, NJ), a Waters Maxima 820 data module, and a Waters 712 WISP. Samples were separated on a reverse-phase column, 25 × 0.5 cm (Partisil 10 ODS-3, Whatman, Clifton, NJ). The mobile phase consisted of acetonitrile:water:85% phosphoric acid (700:300:2) at a flow rate of 1 ml/min. The UV detector was fixed at 254 nm. For assay, 25 μl was injected onto the column. Quantification was achieved by creating a linear calibration plot of instrument response (area units) versus concentration of standards (0.5–200 μg/ml). The correlation coefficient of each day's linear calibration plot was, in each case, at least 0.990. Standards and samples were diluted to volume with acetonitrile. Samples were diluted such that sample concentration measured was between 0.5 and 200 μg/ml. Under the above conditions, benzoic acid had a retention time of 3.6 min with a capacity factor of 0.38 and a 7.8-min retention time for benzoyl peroxide with a capacity factor of 7.5.

Determination of the Dielectric Constant (DEC). Mea-

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1. $BP \xrightarrow{k_i} 2P\bullet$ INITIATION
2. $P\bullet + BP \xrightarrow{k_{p1}} P\bullet$
3. $P\bullet + S \xrightarrow{k_{2p1}} S\bullet$ PROPAGATION
4. $S\bullet + BP \xrightarrow{k_{2p2}} P\bullet$
5. $2P\bullet \xrightarrow{k_{t1}} X$
6. $P\bullet + S\bullet \xrightarrow{k_{t2}} Y$ TERMINATION
7. $2S\bullet \xrightarrow{k_{t3}} Z$

Scheme I. Mechanism of benzoyl peroxide decomposition, where BP represents peroxide, P˙ and S˙ represent unspecified radicals derived from peroxide and solvent, and X, Y, and Z represent unspecified products.

surements were made with an oscillometer (Sargent Chemical Oscillometer Model V, E. H. Sargent and Co., Chicago, IL) at 25°C. The cell constant was calculated to be 6671, derived by measurements with liquids of known dielectric constants: methylene chloride (DEC of 8.93) and water (DEC of 78.5).

Solubility Determinations. An excess of benzoyl peroxide (1.0 g) was added to 10-ml glass culture tubes with Teflon-lined closures containing 5 ml of either ethanol, propylene glycol, glycerol, ethanol/water (1:1), propylene glycol/water (75:25), or PEG 400/propylene glycol (6:4, w/w). These tubes were rotated on a shaker maintained at ambient temperature for 24 hr, centrifuged, and filtered (0.5-μm nylon filter, Spartan-25, Schleicher and Schuell). An aliquot of the filtrate was weighed (approximately 200 mg) and diluted appropriately for HPLC measurement.

In a 125-ml flask containing approximately 100 ml of PEG 400, an excess of benzoyl peroxide (10 g) was added, stirred overnight, centrifuged, and filtered. An aliquot (approximately 200 mg) of the filtrate was diluted appropriately for HPLC measurement. Solubility of benzoyl peroxide in PEG 400/water cosolvent mixtures (10, 20, 30, 40, 50, 60, 70, 80, and 90% PEG 400, w/w) was determined by adding, by weight, a specific amount of PEG 400 filtrate saturated with benzoyl peroxide to a specific weight of water in a 10-ml culture tube such that the total weight was 5.00 g. The tubes were rotated on a shaker for 24 hr, then filtered, and an aliquot was weighed (approximately 200 mg) and diluted appropriately for HPLC measurement.

Preparation of Solution for Stability Studies. The solution stability of benzoyl peroxide was performed in cosolvent mixtures of PEG 400/water (100, 90, 80, and 70% PEG 400, w/w), PEG 400/propylene glycol (6/4, w/w), ethanol, and propylene glycol. The concentrations of benzoyl peroxide (mg/g) in these solvents are presented in Table II. Solutions were transferred to 25-ml glass vials with polypropylene-lined tops and placed at ambient temperature, in darkened stability ovens maintained at 40, 50, and 70°C (±2°C) at ambient relative humidity. At specific time intervals, an aliquot was weighed (approximately 200 mg) and diluted appropriately for HPLC measurement. For stability studies at 70°C, benzoyl peroxide was diluted with solvent previously heated to 70°C.

Preparation of Suspensions for Stability Studies. Benzoyl peroxide suspensions were prepared at 10% (w/w) in 10-ml glass culture tubes with Teflon-lined closures. In each case, 200 mg of benzoyl peroxide was added to 1.8 g of solvent. The solvents used were PEG 400, PEG 400/water cosolvent mixtures (90, 80, 70, 60, and 30% PEG 400), PEG 400/propylene glycol (6:4), ethanol, propylene glycol, and water. All cosolvent mixtures were prepared by percentage (w/w). Suspensions were placed at ambient temperature and shaken on a weekly basis. At a specific time interval, acetonitrile was added to the culture tube, and the contents were dissolved, quantitatively transferred to a 250-ml volumetric, and diluted to volume. Samples were further diluted for HPLC measurement.

RESULTS AND DISCUSSION

Solubility. The solubility values of benzoyl peroxide obtained in this study appear in Table I. The solubility of benzoyl peroxide in mixtures of PEG 400 and water decreased as the ratio of water in the mixture increased. A 67,000-fold increase in solubility was observed from 10% PEG 400 (0.6 μg/g) to PEG 400 (40 mg/g). Gorman and Hall showed that linear relationships are obtained for plots of log mole fraction of solute versus dielectric constant of the solvent blend (10). Further, plots of log mole fraction of secobarbital in blends of ethanol/water, propylene glycol/water, and glycerol/water versus dielectric constant produced three separate regression lines (10). These authors concluded that although linear relationships of solubility and dielectric constant may exist for a compound in a specific solvent blend, this relationship may be quantitatively different for different solvent blends. However, this present study leads to a different conclusion. When the log mole fraction of benzoyl peroxide, calculated from the solubility values, was plotted versus the dielectric constant for the various solvents and solvent blends, a single linear relationship was observed ($r = 0.991$, $P = 0.001$) with the following calculated regression equation: log mole fraction = 0.191 − 0.103 * DEC (Fig. 1). Hence, it should be possible to estimate the solubility of benzoyl peroxide in various solvent blends of ethanol, propylene glycol, PEG 400, glycerol, and water using the calculated regression equation if the dielectric constant of the blend is known. Experimentally, the solubility of benzoyl peroxide in water was below the detection level of the assay method (0.5 μg/ml); however, an extrapolation from the solubility values of the PEG 400 blends suggests the approximate solubility of benzoyl peroxide in water to be 0.2 μg/g.

Solution Stability. Benzoyl peroxide in solution degraded in all the solvents studied, varying depending on the solvent type and concentration of benzoyl peroxide. In some instances, decomposition was not a simple first-order process. The calculated reaction half-lives are given in Table II.

Rapid degradation occurred in PEG 400 but was much slower in ethanol and propylene glycol. The degradation of benzoyl peroxide in PEG 400 (0.5 mg/g), ethanol, and propylene glycol exhibited first-order kinetics, with calculated half-lives of 1.4, 29, and 53 days at 40°C, respectively. Alcohols and ethers are able to accelerate the decomposition of benzoyl peroxide by the process called chain transfer (3,4,6). A solvent radical is formed when a benzoate radical ab-

Table I. Solubility of Benzoyl Peroxide in Various Solvents

Solvent	Solubility (mg/g) determination 1	Solubility (mg/g) determination 2	Dielectric constant
PEG 400	39.6	40.0	14.4
PEG 400/water			
9:1	15.9	12.5	23.0
8:2	2.47	2.51	30.3
7:3	1.30	1.70	36.9
6:4	0.288	0.388	43.2
5:5	0.127	0.129	48.2
4:6	0.0377	0.0377	55.8
3:7	0.0124	0.0124	60.2
2:8	0.00325	0.00329	62.2
1:9	0.000528	0.000628	69.2
PEG 400/propylene glycol (6:4)	19.2	16.0	19.9
Ethanol	17.9	17.7	24.9
Ethanol/water (1:1)	0.77	0.76	46.5
Propylene glycol	2.95	2.95	28.3
Propylene glycol/water (75:25)	0.36	0.37	43.5
Glycerine	0.15	0.15	42.5[a]
Water	0.000155[b]		78.5[a]

[a] Value obtained from NBS circular 514.
[b] Extrapolated estimate.

stracts a proton from the solvent, forming benzoic acid as a degradation product (Scheme I). Benzoic acid was identified as a degradation product in this study (Fig. 2). The solvent radical is able to propagate a chain reaction by reacting with benzoyl peroxide. If the solvent radical formed is more stable than the benzoate radical and therefore less reactive, then the effect will be to suppress the chain decomposition. However, if the chain transfer to the solvent yields a new radical comparable in activity to the benzoate radical, then the effect will be to accelerate the decomposition of benzoyl peroxide. In the case of ethers, radicals are formed from the abstraction of a hydrogen bonded to the methylene carbon.

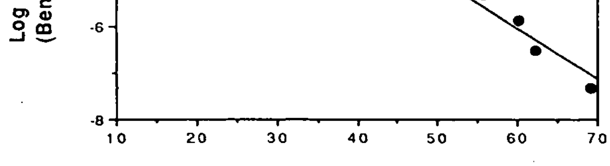

Fig. 1. The log mole fraction of benzoyl peroxide in hydroxy-containing solvents at room temperature: PEG 400 blends (●), propylene glycol blends (○), ethanol blends (■), and glycerol (□).

For example, Cass (3) showed that the degradation products of benzoyl peroxide in 1,2-diethoxyethane were a mixture of carbon dioxide, benzoic acid, and two isomeric acylals, 1-(2-ethoxyethoxy) ethyl benzoate and 1,2-diethoxyethyl benzoate, with recovered yields of 0.18, 0.79, and 0.90 mol per mol of benzoyl peroxide decomposed, respectively. The recovery of the two acylals suggested that radical cleavage occurred at the C–H bond rather than the C–O bond. In the case of alcohols, it has been shown that the chain reaction involves attack by the benzoate radical upon the C–H bond of the alcohol in the alpha position of the oxygen, with the major degradation product being aldehyde and benzoic acid. This reactive pathway may be similar in PEG 400 but could be more complicated since PEG 400 contains between 8.2 and 9.1 ethyleneoxide units and 2 hydroxy units per molecule.

Reaction orders in PEG 400 and PEG 400/water blends were found to be dependent on the benzoyl peroxide concentration. The higher-concentration sample (1.5 mg/g) degraded at an accelerated rate compared to the low-concentration sample (0.5 mg/g). This effect is shown in Fig. 3. At a low concentration (0.5 mg/g), the kinetic data were best fitted to a first-order plot (Fig. 4), whereas at a higher concentration (1.5 mg/g), the data were best fitted to a three-halves-order plot. A three-halves-order reaction was indicated by obtaining a linear plot when the inverse of the square root of concentration of benzoyl peroxide was plotted against time. The slope change seen in Fig. 4 for the degradation of benzoyl peroxide in 70 and 80% PEG 400 at 25°C did not occur at other elevated temperatures and is explained later. In PEG 400 at 25°C, the calculated half-life increased by more than a factor of two when the concentration of benzoyl peroxide was decreased from 1.5 mg/g (6.3 days) to 0.5 mg/g (16 days). Better stability at lower benzoyl peroxide concentration was also observed in 90% PEG 400, with a

Table II. Reaction Rate Half-Lives (Days) for Benzoyl Peroxide in Solution

Solvent system	Reaction order	Conc. (mg/g)	Calculated reaction rate half-life (days) at 25°C (r)	40°C (r)	50°C (r)	70°C (r)
PEG 400						
100%	1.0	0.50	16.0 (0.999)[a]	1.40 (0.993)	0.70 (0.996)	0.07 (0.994)
90%	1.0	0.50	22.0 (0.999)	1.50 (0.992)	0.70 (0.996)	0.07 (0.993)
80%	1.0	0.50	29.0[b]	2.60 (0.997)	1.10 (0.999)	0.07 (0.989)
70%	1.0	0.50	47.0[b]	3.80 (0.995)	1.60 (0.991)	0.07 (0.993)
100%	1.5	1.50	6.3 (0.996)	0.71 (0.987)	0.25 (0.998)	—[c]
90%	1.5	1.50	11.0 (0.995)	0.65 (0.998)	0.24 (0.999)	—
PEG 400, propylene glycol (6:4)	1.5	1.80	19.2 (0.987)	0.57 (0.997)	0.26 (0.997)	—
Ethanol	1.0	2.60	266[d] (0.984)	29.00 (0.997)	17.00 (0.997)	—
Propylene glycol	1.0	2.00	247[d] (0.992)	53.00 (0.992)	25.40 (0.999)	—

[a] Reaction rate order correlation coefficient.
[b] Value obtained graphically.
[c] No value at this temperature.
[d] Less than 23% degradation after 90 days.

half-life of 22 days at 0.5 mg/g, compared to 11 days at 1.5 mg/g. This concentration effect on reaction rate was also observed by Gupta (11) in cosolvent mixtures of propylene glycol and acetone (1:1) at benzoyl peroxide concentrations of 1.0 and 0.1% (w/v).

The change in reaction order can be explained by understanding the kinetics of a free radical reaction (6,8). The kinetics of the decomposition of benzoyl peroxide depends on application of the steady-state approximations with regard to the radical intermediates. Such intermediates, benzoate- and solvent-derived radicals, are highly reactive, and their concentrations are considered to be constant throughout the reaction. The result of the steady-state conditions is that the rate of initiation equals the rate of termination. If this were not the case, free radicals would be present at high concentrations. Assuming that termination occurs between two solvent radicals [S$^{\cdot}$] as shown in Scheme I, the following equation is derived (8):

$$\text{Rate} = k_{2p2}(k_i/2k_{t3})^{1/2}\,[\text{BP}]^{3/2} \quad (1)$$

which is three-halves order with respect to benzoyl peroxide concentration. In the case where termination occurs between a benzoate-derived radical and a solvent radical, the following rate equation is derived:

$$\text{Rate} = (k_i k_{2p1} k_{2p2}/k_{t2})^{1/2}\,[\text{S}]^{1/2}[\text{BP}] \quad (2)$$

which is first order with respect to BP concentration. The derivation of Eq. (2) is given in the Appendix. The effect of solvent type on reaction order is evident by comparing the reaction order of benzoyl peroxide in propylene glycol and a cosolvent mixture of PEG 400 and propylene glycol (6/4). In propylene glycol the reaction followed first-order kinetics, compared to three-halves-order kinetics in PEG 400/propylene glycol. It is obvious that the reaction is terminated by the coupling of two solvent radicals by the addition of PEG 400 to propylene glycol.

It was also observed that as the temperature was increased from 25 to 70°C, the disparity between reaction half-life, at the different PEG 400 blends, became less, such that with benzoyl peroxide concentrations of 0.5 mg/g at 70°C and 1.5 mg/g at 50°C, there were no measurable differences in half-life. At elevated temperatures thermal decomposition is more facile. Hence the chain length of the overall reaction may become less, remembering that chain length is defined as the number of propagation steps per initiation step. Therefore, at elevated temperatures the differences in solvent composition for the PEG 400 blends become less important.

At 25°C the degradation of benzoyl peroxide solutions containing 70 and 80% PEG 400, when plotted as first-order reactions, exhibited a lag phase, after which the reaction rate increased after approximately 14 days for 80% PEG 400 and 21 days for 70% PEG 400. The lag phase may represent the initiation reaction (Scheme I), which is characteristic of most free radical reactions (12). Here, the initiation reactions represent the thermal decomposition of benzoyl peroxide. The degradation rate increases after enough solvent radicals and benzoyl peroxide-derived radicals, which are more reactive, are generated to facilitate radical propagation. In PEG 400 and 90% PEG 400 at 25°C, the initiation reaction may occur more rapidly relative to the 70 and 80% PEG 400 solutions and is not readily observable.

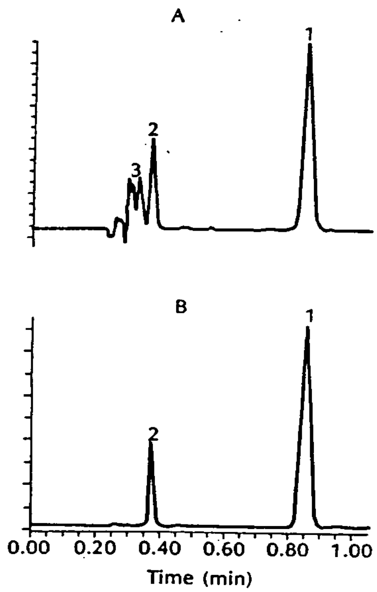

Fig. 2. Chromatograms of benzoyl peroxide and benzoic acid (A) when stored at 70°C for 4 hr in PEG 400 and (B) standard solution of benzoyl peroxide and benzoic acid (100 mg/ml). (1) Benzoyl peroxide; (2) benzoic acid; (3) unknown products.

Suspension Stability. The stability of benzoyl peroxide suspensions in various solvents appears in Table III. Benzoyl peroxide was most stable in water, propylene glycol, and PEG 400/water (30/70) and least stable in PEG 400. The addition of water to PEG 400 enhanced the stability such that, in a suspension containing 70% water, there was no observed degradation after 90 days. This result could be due in part to the concentration of benzoyl peroxide in solution as determined by solubility. Indeed, when the solubility of benzoyl peroxide was plotted against the corresponding reaction rate in PEG 400 and PEG 400 water blends, a correlation was found to exist ($r = 0.989$, $P = 0.05$) (Fig. 5). No degradation was observed in propylene glycol after 90 days,

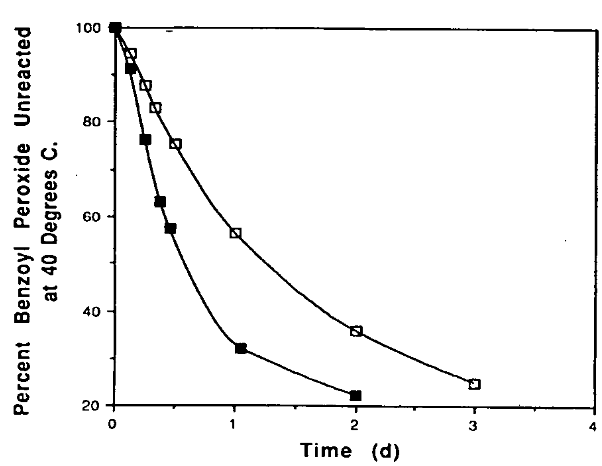

Fig. 3. The effect of concentration on the degradation of benzoyl peroxide in PEG 400: 0.5 mg/ml (□) and 1.5 mg/g (■).

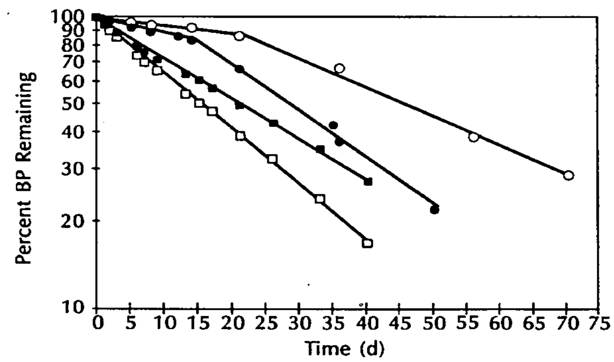

Fig. 4. The effect of solvent blend on first-order degradation of benzoyl peroxide (0.5 mg/g) at 25°C in PEG 400 (□), 90% PEG 400 (■), 80% PEG 400 (●), and 70% PEG 400 (○).

but when propylene glycol was added to PEG 400 the rate of degradation averaged 0.78% per day.

A first-order reaction rate constant for benzoyl peroxide in ethanol at 25°C was calculated from the stability data of the benzoyl peroxide suspension. The decomposition of benzoyl peroxide in a 10% suspension of ethanol at 25°C was observed to be 0.05% over a 24-hr period. A 10% (w/w) suspension is equivalent to 100 mg of drug substance in 0.9 g of ethanol. Hence, the apparent zero-order rate constant, k_0, can be expressed as 0.0500 mg of benzoyl peroxide decomposed per g of suspension per day. The average solubility of benzoyl peroxide in ethanol was 17.8 mg/g (Table I). The apparent zero-order rate constant is related to the first-order reaction rate constant, $k_{25°C}$, by the following equation:

$$k_0 = k_{25°C} \times (\text{BP solubility}) \qquad (3)$$

$$k_0 = k_{25°C} \times (17.8 \text{ mg/g}) \qquad (4)$$

$$k_{25°C} = 0.0028 \text{ day}^{-1} \qquad (5)$$

This $k_{25°C}$ for suspension is in agreement with the experimental solution reaction rate constant of 0.0026 day^{-1} for benzoyl peroxide in ethanol (Table II).

Table III. Degradation of Benzoyl Peroxide (BP) in Suspensions (10%, w/w) at 25°C

Solvent	Decomposition rate determination (% BP/g/day) 1	2
PEG 400	3.5	3.5
PEG 400		
90%	1.4	1.8
80%	0.66	0.76
70%	0.29	0.29
60%	0.02	0.02
30%	—[a]	
Water	—	
PEG 400/PG (6:4)	0.68	0.88
Ethanol	0.05	0.05
Propylene glycol	—	

[a] No change after 90 days.

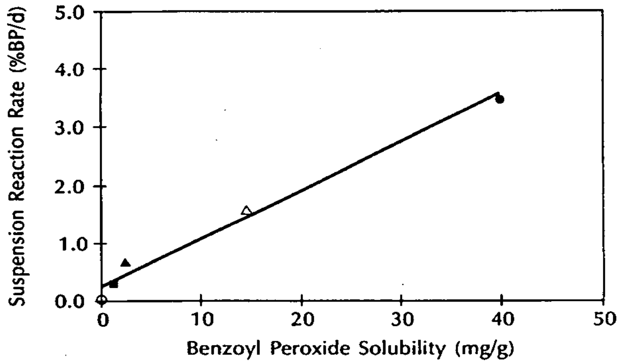

Fig. 5. The effect of benzoyl peroxide solubility of various PEG 400 and PEG 400 water blends on suspension reaction rates at room temperature: PEG 400 (●), 90% PEG 400 (△), 80% PEG 400 (▲), 70% PEG 400 (■), and 60% PEG 400 (○).

APPENDIX

The equation for the solvent-induced first-order decomposition of benzoyl peroxide [Eq. (2)] is derived by assuming that the overall reaction rate is that of either propagation step, with termination occurring by the coupling of a solvent radical with a benzoate-derived radical. Hence, in this example, using the propagation step where the solvent radical reacts with benzoyl peroxide, the rate of the overall reaction becomes

$$\text{Rate} = k_{2p2}[\text{BP}][\text{S}^\cdot] \quad \text{(A1)}$$

To solve for $[\text{S}^\cdot]$, the following steady-state approximations are made using k_{t2} for the termination step:

$$d[\text{P}^\cdot]/dt = 0 = 2k_i[\text{BP}] - k_{2p1}[\text{P}^\cdot][\text{S}] + k_{2p2}[\text{S}^\cdot][\text{BP}] - k_{t2}[\text{P}^\cdot][\text{S}^\cdot] \quad \text{(A2)}$$

$$d[\text{S}^\cdot]/dt = 0 = k_{2p1}[\text{P}^\cdot][\text{S}] - k_{2p2}[\text{S}^\cdot][\text{BP}] - k_{t2}[\text{P}^\cdot][\text{S}^\cdot] \quad \text{(A3)}$$

Therefore,

$$[\text{P}^\cdot] = (2k_i[\text{BP}] + k_{2p2}[\text{S}^\cdot][\text{BP}])/(k_{2p1}[\text{S}] + k_{t2}[\text{S}^\cdot]) \quad \text{(A4)}$$

$$[\text{S}^\cdot] = k_{2p1}[\text{P}^\cdot][\text{S}]/(k_{2p2}[\text{BP}] + k_{t2}[\text{P}^\cdot]) \quad \text{(A5)}$$

Substituting $[\text{P}^\cdot]$ in Eq. (A5) with Eq. (A4) yields the following quadratic equation:

$$k_{2p2}k_{t2}[\text{S}^\cdot]^2 + k_ik_{t2}[\text{S}^\cdot] - k_ik_{2p1}[\text{S}] = 0 \quad \text{(A6)}$$

which, when solved for $[\text{S}^\cdot]$, gives

$$[\text{S}^\cdot] = (k_ik_{2p1}k_{t2})^{1/2}\,[\text{S}]^{1/2}/k_{2p2}^{1/2}k_{t2} \quad \text{(A7)}$$

Substituting Eq. (A7) for $[\text{S}^\cdot]$ in Eq. (A1) yields the following rate equation:

$$\text{Rate} = (k_ik_{2p1}k_{2p2}/k_{t2})^{1/2}\,[\text{S}]^{1/2}\,[\text{BP}] \quad \text{(A8)}$$

which is first order with respect to benzoyl peroxide concentration.

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Whitening Toothpastes

Product names (dates of ADA Acceptance): Crest Extra Whitening With Tartar Protection Toothpaste (received ADA Seal of Acceptance in September 1999), Crest Multicare Whitening Toothpaste (February 2000), Colgate Tartar Control Plus Whitening Gel (March 2000), Aquafresh Whitening Toothpaste (April 2000), Colgate Total Plus Whitening Toothpaste (June 2000), Rembrandt Whitening Toothpaste (October 2000)

Manufacturers: Crest—Procter & Gamble, P.O. Box 599, Cincinnati, Ohio 45201-0599, 1-800-492-7378, "www.pg.com"; Colgate—Colgate-Palmolive Company, 300 Park Ave., New York, N.Y. 10022, 1-800-468-6502, "www.colgate.com"; Aquafresh—GlaxoSmithKline, P.O. Box 1467, Pittsburgh, Pa. 15230, 1-800-897-5623, "www.aquafresh.com"; Rembrandt—Den-Mat Corporation, 2727 Skyway Drive, Santa Maria, Calif. 93455, 1-800-433-6628, "www.rembrandt.com"

Description: Toothpastes typically contain abrasives (to remove debris and residual stain), humectants (to prevent loss of water), thickening agents or binders (to stabilize toothpaste formulations and prevent separation of liquid and solid phases), and flavoring and foaming agents (a preference of consumers). Therapeutic agents include fluoride (contained in all ADA-Accepted toothpastes for reducing caries), potassium nitrate (to treat dentinal hypersensitivity), and triclosan or stannous fluoride (to reduce gingival inflammation). Other agents that may be added to toothpastes to provide esthetic benefits are pyrophosphates or zinc citrate (to prevent tartar buildup) and various abrasives or enzymes (to help whiten teeth). Toothpastes that whiten teeth work by chemically or mechanically removing stain. The outcome is stain removal without damage to the underlying tooth structure. Whitening toothpastes that remove surface stain should not be confused with bleaching agents that work by breaking down pigment to remove color from teeth.

ADA ACCEPTED American Dental Association

"(Product Name) is an "Accepted" HOME-USE TOOTH WHITENING MATERIAL when used according to the manufacturer's instructions. Council on Scientific Affairs, American Dental Association

Considerations for Acceptance: The basis for review of all toothpastes submitted to the ADA Acceptance Program are the Guidelines for Fluoride-Containing Dentifrices. These guidelines detail the testing required to demonstrate that the dentifrice is safe and effectively prevents caries. In addition to this testing, whitening toothpastes are evaluated according to the ADA Acceptance Program Guidelines for Home-Use Tooth Whitening Products. Any other therapeutic claim attributed to whitening toothpastes also must be supported with studies (for example, claims for the reduction of plaque and gingivitis or hypersensitivity should be supported by studies consistent with ADA guidelines). ADA consultants review the testing results supplied by the toothpaste manufacturers.

Efficacy Data: Toothpaste manufacturers conduct extensive fluoride testing. This testing includes measurement of fluoride concentration, fluoride release in one minute (comparable to normal brushing habits) and incorporation of fluoride into enamel. The ADA laboratory conducts some fluoride testing as well. In addition to the fluoride data, two independent clinical studies must be conducted demonstrating the ability of the toothpaste to whiten teeth. The criteria for the clinical studies are double-blinding, study duration of six to eight weeks (with assessments pretreatment, midtreatment and posttreatment), treatment and control groups (at least 25 subjects per group), assessments of at least four maxillary anterior teeth and color change measurements by either devices (such as colorimeters or spectrophotometers) or special color-matching scales (such as shade guides).

Safety Data and Toxicity: Whitening toothpastes submitted to the Acceptance program must complete the following evaluations demonstrating safety:

- measurement of enamel hardness to identify any damage to dental enamel and dentin with extreme use of the toothpaste;
- assessments of enamel morphology to identify any degradation of the enamel surface;
- testing to identify any effect of the whitener on restorative materials;
- toxicological assessments to identify cytotoxicity, mutagenicity and the potential for mucosal irritation.

In addition, periodontal health measurements must be made and any adverse events must be reported.

Mechanism of Action: The whitening ingredients in Crest and Colgate whitening toothpastes are special silica abrasives that prevent the formation of stains and remove stain from the tooth surface. The whitening ingredient in Aquafresh is sodium tripolyphosphate, a surfactant and chelator, that is effective against calcified stain. Rembrandt contains Citroxane, a patented formula that chemically disrupts stain through the combined action of papain, citrate and aluminum oxide. Papain is a proteolytic enzyme that is thought to whiten by dissolving the proteinaceous component of the stain. Citrate is added to enhance the activity of papain. Aluminum oxide is a mild abrasive. All these toothpastes whiten by removing stained pellicle on the tooth surface.

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Toothpaste formulation

Practicing good oral hygiene results in the reduction of plaque, caries and gingivitis. Toothpastes improve oral hygiene by enhancing the effect of mechanical scrubbing with a toothbrush and by delivering therapeutic agents to the oral cavity. The composition of toothpastes can be modified depending on the targeted therapy; however, the main therapeutic effect is a reduction of caries that occurs through assimilation of fluoride ions into the apatite crystal of enamel. Fluoride in toothpaste is in the form of sodium fluoride, stannous fluoride or sodium monofluorophosphate. In addition to their anticaries effect, most toothpastes can be broadly classified as having antitartar, cosmetic, antigingivitis, antiplaque or antihypersensitivity effects, or some combination of these effects.

THE COMPONENTS OF TOOTHPASTE

Abrasives. Abrasives are added to toothpaste to remove stained pellicle from dentition. Abrasives work in concert with the toothbrush and have no effect on their own. The removal of plaque also is associated minimally with abrasives, which is another action attributed to the toothbrush. Calcium carbonate, dicalcium phosphates, hydrated alumina and various silica compounds are used as abrasives in toothpaste. The factors that affect the cleaning agent's abrasivity are hydration, particle size and shape, source, purity, and physical or chemical treatment. Ideally, abrasives should be nearly inert chemically. Toothpastes are tested to determine whether the abrasive component is satisfactory for removal of stain, while not damaging to the tooth structure.

Detergents. Detergents also are added to toothpastes for cleaning. Detergents act by lowering surface tension to solubilize substances, allowing penetration and loosening of surface deposits. The foaming action of toothpastes results from the addition of detergents. It is important that the detergent added to a toothpaste is mild so that it does not irritate the oral mucosa. The most commonly used detergent is sodium lauryl sulfate. There have been reports of sodium lauryl sulfate's causing increased oral irritation in people who have recurring aphthous ulcers. For such people, manufacturers make toothpastes that do not contain sodium lauryl sulfate.

Humectant systems. Humectants and binding agents are important ingredients for maintaining the consistency of toothpaste. They are combined with preservatives to form complex mixtures referred to as humectant systems, which fulfill three purposes:

- providing a vehicle to which the other ingredients can be incorporated;
- keeping moisture in the toothpaste;
- preventing the growth of microorganisms.

The humectants commonly used are polyols (that is, glycerin, sorbitol and hydrogenated starch hydrolyzates). The preservative usually added is sodium benzoate. Binding agents are hydrophilic colloids that prevent separation of the toothpaste components by maintaining the liquid and solid components in one phase. A naturally occurring binding agent is gum arabic; synthetic ones include sodium carboxymethylcellulose and magnesium aluminum silicate.

Flavoring agents. Either natural flavoring agents (such as spearmint, peppermint, wintergreen, cinnamon, anise and fruit extracts) or artificial flavoring agents are added to toothpaste. ADA-Accepted toothpastes do not contain sugar, but some do contain artificial sweeteners (such as saccharin). The humectants glycerin and sorbitol also give toothpaste a sweet taste.

FORMULATION: AN IMPORTANT CONSIDERATION

The combination of ingredients selected for a toothpaste depends on the desired qualities of the toothpaste and on the ingredients' compatibility. A toothpaste's formulation is an important consideration, because some ingredients can interfere with the effectiveness of others. For example, some cleaning agents have been shown to interfere with the availability of some therapeutic agents. The purity and chemical nature of the toothpaste ingredients, therefore, have become an important consideration. ■

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August 2007 – present: : **Director and Professor,** School of Polymers and High Performance Materials, **Director of the Institute for Formulation Science,** The University of Southern Mississippi, Hattiesburg, Mississippi

January 2006 –August 2007: **Professor,** School of Polymers and High Performance Materials, **Director of the Institute for Formulation Science,** The University of Southern Mississippi, Hattiesburg, Mississippi

2004 –January 2006. **Interim Director,** School of Polymers and High Performance Materials, The University of Southern Mississippi, Hattiesburg, Mississippi

2003-May 2004 **Professor,** School of Polymers and High Performance Materials, The University of Southern Mississippi, Hattiesburg, Mississippi

2001-2003 **Dean,** The College of Science and Technology, The University of Southern Mississippi, Hattiesburg, Mississippi.

2000-2001 **Director,** School of Polymers and High Performance Materials, and **Chair**, Department of Polymer Science, The University of Southern Mississippi, Hattiesburg, Mississippi.

1999-2000 **Chair**, School of Polymers and High Performance Materials, The University of Southern Mississippi, Hattiesburg, Mississippi

1993-1999 **Chair,** Department of Polymer Science, The University of Southern Mississippi, Hattiesburg, Mississippi

1990-93 **Associate Professor**, Department of Polymer Science, The University of Southern Mississippi, Hattiesburg, Mississippi.

1987-95 **Adjunct Faculty Member**, Department of Pharmacy, University of Cincinnati, Cincinnati, Ohio.

1979-90 **R&D Manager for Hydrophilic Polymers**, BF Goodrich, Avon Lake and Brecksville, Ohio. Job content: polymer synthesis and scale-up; applications research; surface and colloid science; formulation science for cosmetics, pharmaceuticals, detergents, and textile print-pastes.

1970-79 **Scientist and Manager**, Unilever Research, Isleworth, England. Job content: polymer synthesis, colloid and surface science.

1961-65 **Laboratory Assistant and Experimental Officer**. Nobel Division of Imperial Chemical Industries, Ardeer, Scotland. Analytical chemistry.

1961 **Laboratory Assistant**. J&R Tennent, Brewers, Glasgow, Scotland

HONORS, PROFESSIONAL SOCIETIES AND EXAMPLES OF SERVICE

The IFSCC Congress, Osaka, October 2006. Keynote Speaker.
Gordon Research Conference on Mammalian Skin: Plenary Lecturer, August 2005
Department of Energy, Committee of Visitors, NABIR, 2004
State Of Mississippi: "The Governor's Education Achievement Award – Higher Education" 2001 Winner.

SACS Accreditation reviewer for the University of Houston, Clearlake. 2002
Peer Reviewer for KTEC, 2001
American Chemical Society, Member
American Oil Chemists' Society, Member
American Soybean Association,
    Member of Surfactants Technical Advisory Board, 1998
Association of Formulation Chemists
    President 2000-2002
    Senior Vice President 1999
    Vice President, 1998
    Member 1997
Elsevier Science, Colloids & Surfaces A: Physicochemical & Engineering Aspects
    Editorial Board, 1996 to 2004
Society of Cosmetic Chemists
    Fellow of the Society of Cosmetic Chemists
    Recipient of National Merit Award,, 2006
    Recipient of the Maison G. deNavarre Medal Award for outstanding contributions to the Art and Science of Cosmetics, 2000
    Accreditation Task Force, 2001 -present
    Committee on Scientific Affairs, 1988- 1997, 1999- 2001, 2006- present
    Editorial Board, 1998-present
    Fellowship Committee, 1998-present
    Merit Award Committee Chair, 1999, 2000
    Chair, Partnership Award Committee, 1998
    Chair, Best Paper Award Committee, 1998
    Committee on Scientific Affairs, 1990 1993, 1998-2002, 2006 -
    Chair, Strategic Planning Committee, 1996
    Past President, 1999
    President, 1994
    Vice President, 1993
    Vice President Elect, 1992
    Executive Board Member, 1992-95
    Board Member, 1992-95
    Committee on Scientific Affairs, Presiding Officer, 1992-93
    Institutional Grants Committee, Chair, 1992
    Committee for Chapter Affairs, Presiding Officer, 1992
    Lake Erie Chapter Chair, 1986
    National Best Paper Award, 1991
    National Best Paper Award, 1995
    National Best Paper Award, 1996
    National Best Paper Award, 1998
    National Best Paper Award, 1999
    National Best Paper Award, 2007
    Best Student Presentation, 2002
    Best Student Presentation, 2006
    New York Chapter: Best Presentation of the Year Award, 2002

Council for Chemical Research, Inc.
    Science Education and Human Resources Committee 1994-1997
    Congessional and Interagency Rapid Action Taskforce 2000-present

Cosmetic, Toiletry and Fragrance Association
    Member of International Nomenclature Committee (2003-present)
    Consultant to the C.T.F.A.

La Societe Francaise de Chemie, Le Groupe Formulation, Committee de Science, 2001

The Royal Society of Chemistry
Fellow of the Royal Society of Chemistry
The Royal Society of Chemistry: Invited Speaker, November, 2005

United Nations Industrial Development Organization - Mission Expert

RESEARCH INTERESTS

Combinatorial experimentation
Formulation science
Polymer solution theory
Polymer behavior at interfaces
Polymer/surfactant interaction
Colloid and surface science
Stabilization of dispersions and emulsions using polymers
Controlled release from polymer matrices

EXPERT TESTIMONY

I have testified as an expert by deposition in the following cases in the preceding five years:

Revlon Consumer Products Corporation v. The Estee Lauder Companies, Inc. Estee Lauder, Inc. and Origins Natural Resources, Inc, Civil Action No. 00-CIV-5960 (RMB) in the United States District Court, Southern District of New York

3M Innovative Products Company and 3M Company v. Dentsply International Inc. Civil Action No. 04 C 0465 S, in the United States District Court for the Western District of Wisconsin.

L'Oreal S.A. and L'Oreal USA Inc.v The Estee Lauder Companies Inc., Estee Lauder Inc., and Origins Natural Resources, Inc., Civil Action No: 04-1660 (HAA) , in the United States District Court for the District of New Jersey.

L.P. Matthews L.L. C. v Bath & Body Work Inc., Limited Brands Inc. Kao Brands Company (f/k/a the Andrew Jergens Company), and Kao Corporation. , Civil Action No: 04- 1507-5LR, In the United States District Court for the District of Delaware.

PATENTS

"In Vivo Polymerizable Ohhthalmic Compositions", Charles, Steven T.,, Hammer, Mark E., Lang, John C., Lochhead, Robert Y., Mathias, Lon J., European Patent 973,514 B1, March 5, 2003, assigned to Alcon Labs and the University of Southern Mississippi

Hammer; Mark E.; Charles; Steven T.; Lang; John C.; **Lochhead; Robert Y.**; Mathias; Lon J.; United States Patent 6,180,687; January 30, 2001; assigned to Alcon Labs and the University of Southern Mississippi.

Hammer, M. E.; S. T. Charles; J. C. Lang; **R. Y. Lochhead**; L. J. Mathias; "Articles coated with in vivo polymerizable ophthalmic compositions," U. S. Patent No. 6, 124,037, September 26, 2000; assigned to Alcon Labs and the University of Southern Mississippi.

"Polymerizable Mesophases Based on Substituted Unsaturated Carboxylic Acids," **R. Y. Lochhead**; L. J. Mathias; U.S. Patent 6,046,292; April 4, 2000; assigned to The University of Southern Mississippi;

"Single-Phase Soap Compositions," E. T. Lance-Gomez; M. M. Gipp; **R. Y. Lochhead**; C. E. Seaman, Jr.; U.S. Patent 6,007,769; December 28, 1999; assigned to S. C. Johnson & Son, Inc. and The University of Southern Mississippi.

"Surfactants Formed From Menhaden Fish," **R. Y. Lochhead**; R. Bateman; M. Tisack; Mikhail Gololobov; U.S. Patent 5,985,840; November 16,1999; assigned to The University of Southern Mississippi;

"Polymerizable Mesophases Based on Substituted Unsaturated Carboxylic Acids," **R. Y. Lochhead**; L. J. Mathias; U.S. Patent 5,905,127; May 18, 1999; assigned to The University of Southern Mississippi;

"In *Vivo* Polymerizable Opthalmic Compositions," S. T. Charles; M. E. Hammer; J. C. Lang; **R. Y. Lochhead**; L. J. Mathias; U.S. Patent 5,858,345; January 12, 1999; European Patent 973514A1, World Patent WO9844915A1, assigned to Alcon Laboratories and The University of Southern Mississippi.

"Single-Phase Soap Compositions," E. T. Lance-Gomez; M. M. Gipp; **R. Y. Lochhead**; C. E. Seaman, Jr.; U.S. Patent 5,820,695; October 13, 1998; European Patent EP0785985A1, World Patent WO9607724A1: assigned to S. C. Johnson & Son, Inc. and The University of Southern Mississippi.

"Emulsions Comprising a High Molecular Weight Anionic Emulsifying Agent," J. Y. Castaneda and **R. Y. Lochhead;** European Patent 482417 A1; April 29, 1992; assigned to BF Goodrich.

"Bioadhesive Carboxylic Polymers," C. C. Hsu, **R. Y. Lochhead,** W. F. Masler and E. J. Sehm; European Patent 459373 A2; December 4, 1991; assigned to BF Goodrich.

"Oxidation-Resistant Polymeric Thickeners," C. C. Hsu, R. F. Koebel, **R. Y. Lochhead,** M. K. Nagarajan, C. E. Sauer, and W. F. Masler; European Patent 435066 A2; July 3, 1991; assigned to BF Goodrich.

"Stable and Quick-Breaking Topical Skin Compositions from Oil-in-Water Emulsions Containing Acrylic Polymers," **R. Y. Lochhead,** J. Y. Castaneda and W. J. Hemker; European Patent 268164 A2, May 25, 1988; U.S. Patent 5,004,598, April 2, 1991; assigned to BF Goodrich.

"Suspension Composition for Aqueous Surfactant Systems," **R. Y. Lochhead** and D. S. S. Warfield; U.S. Patent 4,686,254; August 11, 1987; assigned to BF Goodrich.

"Stable Carboxylic Acid Polymers in Mineral Spirits," **R. Y. Lochhead,** T. R. George, W. L. Banks; United States Patent 4,668,731; May 26, 1987, European Patent EP 214460 A1; March 18, 1987; assigned to BF Goodrich.

"Improved process for polymerizing unsaturated acids in mineral spirits" **R. Y. Lochhead** and J. C. Garcia, European Patent EP0107062B1, October 22, 1986, assigned to the BF Goodrich Company,

"Stable Mineral Spirit Dispersions of Carboxyl-Containing Polymers," T. R. George and **R. Y. Lochhead,** U.S. Patent 4,536,628; August 20, 1985; assigned to BF Goodrich.

"Polymerizing Unsaturated Acids in Mineral Spirits," **R. Y. Lochhead** and J. C. Garcia; U.S. Patent 4,420,596; December 13, 1983; assigned to BF Goodrich.

BOOKS, EDITED

Sarah Morgan, Kathleen Havelka, , **Robert Y. Lochhead**, "Cosmetic Nanotechnology", ACS Symposium Series 961, American Chemical Society, 2007.

JOURNAL ARTICLES/BOOK CHAPTERS

Robert Y. Lochhead "Wipes: Recently Disclosed Intellectual Property, *Cosmetics and Toiletries , (2007), 122 (8), p71.*

Laura Silva, **Robert Lochhead,** Lee Tonkovich, Dongming Qiu, "Superior emulsions in microchannel architecture", The Chemical Engineer, March 2007, Issue 789, p38.

Robert Y. Lochhead and Virginia Smith, "The Latest Developments in Skin Care Polymers": HAPPI, April 2007, p73.

Lisa Huisinga and **Robert Y. Lochhead,** "Investigation of the Structure of Polyelectrolyte –Based Complex Coacervates and the Effects of Electrolyte Order of Addition," Chapter 5, pp 97-124 in "Cosmetic Nanotechnology", ACS Symposium Series 961, American Chemical Society, 2007.

Laura Silva, Anna Lee Tonkovich, **Robert Lochhead,** Dongming Qiu, Paul Neagle, Steve Perry, and Jan Lerou , "Advanced Emulsions: Enabling Advanced Emulsions with Microchannel Architecture, Ch 4, pp83-96 in "Cosmetic Nanotechnology", ACS Symposium Series 961, American Chemical Society, 2007.

Robert Y. Lochhead, "The Role of Polymers in Cosmetics: Recent Trends", Chapter 1, pp3-58 , in "Cosmetic Nanotechnology", ACS Symposium Series 961, American Chemical Society, 2007.

Robert Y. Lochhead, "Recent Trends in Hair Care Polymers" *HAPPI , 43(11), (2006),* 83

Robert Y. Lochhead, "Stimuli- Responsive Polymer Systems: A Review of Thermo-associative Thickening:" *Cosmetics and Toiletries , 121 (10), (2006),* 73.

Robert Y. Lochhead, "Emerging Technologies for Cosmetics and Personal Care Wipes:" *Cosmetics and Toiletries , 121 (9), (2006),* 47.

Robert Y. Lochhead, "Recent Trends in Polymers for Skin Care" *HAPPI , 43(4), (2006)*

Robert Y. Lochhead, Cheri L. Mc Connell-Boykin, Camille T. Haynes, Stephen R. Jones and Virginia Smith, "The High Throughput Investigation of Polyphenolic Couples in Biodegradable Packaging Materials." *J. Applied Surface Science. 252(7), (2006),2535*

Robert Y. Lochhead*, Lisa R. Huisinga, Christina Edwards and Anthony Hill, A Combinatorial Investigation of the Effects of Order of Addition in the Interaction of Polyelectrolytes with Surfactants. *Proceedings of the Materials Research Society.* (2006),894, p 153

Silva L.; , Tonkovich , A.L. ; **Lochhead, R.**; Qiu, D.; Pagnatto , K.; Neagle , P.; Perry, S. ; "Enabling Advanced Emulsions in Microchannel Architecture", Cosmetics & Toiletries, 120(9), , (2005).

Lochhead, R.Y.; Huisinga, L.R.;" Some recent trends in personal care polymers"; *HAPPI*, Vol. 42 (4), p, 2005.

Lochhead, R.Y.; Huisinga, L.R.; "Advances in polymers for hair styling". Cosmetics & Toiletries, 120(5), p 69, (2005).

Lochhead, R.Y , "Polymers in Hair Color Products," Cosmetics & Toiletries, 120(7), (2005).

Lochhead, R.Y.; Huisinga, L.R.; "Advances in polymers for hair conditioning shampoos". Cosmetics & Toiletries, 120(5), p 59, (2005).

Corcorran, S; **Lochhead, R.Y.;** McKay,T.; "Particle –stabilized emulsions: A brief overview" *Cosmetics and Toiletries,* Vol. 119(8), p 47, 2004).

Lochhead, R.Y.; Jones, S. ;"Polymers in Cosmetics: Recent advances"; *HAPPI,* Vol. 41 (7), 2004.

Johnson, K. M; Poe, G D'; **Lochhead, R.Y.;** McCormick, C.L.; "The Synthesis of Hydrophobically. Modified Water-soluble Polyzwitterionic Copolymer and Responsiveness to Surfactants in Aqueous Solution", *J. Macromol. Sci., Pure and Appl. Chem.*,p 587, Vol. A 41 (6), 2004

Friberg, S. E; **Lochhead, R.Y.;** Blute, I.; Waernheim, T: "Hydrotropes –Performance Chemicals"; *J. Dispersion Sci. Tech.*; p 243, Vol 25 (3).; 2004

Lochhead, R.Y.; Huisinga, L.R.; **"**A brief review of polymer surfactant interaction", *Cosmetics and Toiletries,* p37, Vol. 119(2), 2004.

Huisinga, L.R.**; Lochhead, R.Y.;** Welch, C; Maggio, S; McKay, T;**"**The development of combinatorial methods for formulation of polymer surfactant systems", *Polymeric Materials Science and Engineering,* p 805, Vol. 90, 2004.

Johnson, K.; Fevola, M.; **Lochhead, R.Y.;** McCormick, C.L.; "Hydrophobically-Modified Acrylamide-Based Polybetaines: II. Interaction with Surfactants in Aqueous Solution", *J. Applied Polymer Science*, p 658, Vol. 92(1), 2004

R. Y. Lochhead C.L. McConnell-Boykin, 'An Investigative Study of Polymer Adsorption to Smectite Clay: Polyelectrolytes and Sodium Montmorillonite", *in "Polymer Nanocomposites" (Editors R. Krishnamoorti and R. Vaia) American Chemical Society, 2002.*

R.Y. Lochhead; C.F. Welch; "Effect of Hydrophobically-Modified Hydroxyethylcellulose on the Phase Morphology of a Model Surfactant Mesophases System in the Liquid Crystal Regime, *Polymer Materials Science and Engineering*, Vol 85, p 67; American Chemical Society, 2001.

R.Y. Lochhead; C.L. McConnell- Boykin; C. Haynes; "Interaction of Hydrophilic Polymers with Smectite Clays, *Polymer Materials Science and Engineering*, Vol 85, p 419; American Chemical Society, 2001
R. Y. Lochhead; Shampoos,, *"The Chemistry and Manufacture of Cosmetics"* Mitchell Schlossman Editor, Chapter 12 *of Volume II* , Allured Press, 2000.

Yamato, N.; D. Kaneko; **R. Y. Lochhead**; "The Investigation of Sodium L-Acyl-N-Glutamate/Cationic Cellulose Interaction," *Proceedings of the International Conference on Colloid and Surface Science,* Tokyo, Japan, November 5-8, 2000

Manuszak-Guerrini, M.; **R. Y. Lochhead**; W. H. Daly; "Interactions of aminoalkylcarbamoyl cellulose derivatives and sodium dodecyl sulfate. 2. Foam stabilization," *Elsevier Science*,Colloids and Surfaces, (1998).

Rulison, C. J.; **R. Y. Lochhead**; "Kinetic Study of the Adsorption of Nonionic and Anionic Surfactants and Hydrophobically Modified Water-Soluble Polymers to Oil-Water Interfaces," in *Surfactant Adsorption and Surface Solubilization*, Ed. Ravi Sharma, ACS Symposium Series 615, pp. 280-315, (1995).

Lochhead, R. Y.; Rulison, C.J.; "An Investigation of the Mechanism by which Hydrophobically-Modified Hydrophilic Polymers Act as Primary Emulsifiers," *Colloids and Surfaces*, A88, 27, (1994).

Lochhead, R. Y.; Y. Chang; C. L. McCormick; "The Effect of Surfactant Addition on the Solution Properties of Amphilic Copolymers of Acrylamide and Dimenthydodecyl(2-acrylamidoethyl)ammonium Bromide," *Macromolecules*, 27, (1994).

Lochhead, R. Y.; "Emulsions," *Cosmetics and Toiletries*, 109, (5), 93, 1994.

Lochhead, R. Y.; "The Rheology of Hair Care Products," Chapter 8 in *Rheological Properties of Cosmetics and Toiletries*, D. Laba, Editor, Marcel Dekker, (1994).

Lochhead, R. Y.; R. Dodwell; W. Hemker; "Pemulen® Polymeric Emulsifiers: What They Are, How They Work," *Cosmetics and Toiletries Manufacture Worldwide*, p. 77, (1993).

Lochhead, R. Y.; *Proceedings of the 20th Waterborne, High Solids and Powder Coatings Symposium*, New Orleans, LA; p. 153, (February 1993).

Lochhead, R. Y.; C. J. Rulison; H. S. Bui; T. D. Pierce; "Investigation of the Mechanism of Emulsification by Hydrophobically-Modified Hydrogels," *Polymer Preprints of the American Chemical Society;* 34 (1), 863, (1993).

Lochhead, R. Y.; C.J. Rulison; "Investigation of the Mechanism and Associative Thickening by Hydrophobically-Modified Hydroxyethylcellulose and Hydrophobically-Modified Poly(acrylic acid)," *Polymer Materials Science and Engineering*, 69, (1993).

Lochhead, R. Y.; W. R. Fron; "The Encyclopedia of Polymers and Thickeners for Cosmetics," *Cosmetics and Toiletries*, 108, (5), 95, (1993).

Lochhead, R. Y.; "Water Soluble Polymers: Solution Adsorption and Interaction Characteristics," *Cosmetics and Toiletries*, *107(9)*, 131, (1992).

Lochhead, R. Y:; "Conditioning Shampoos," *Soaps, Cosmet., Chem. Spec.*, *68(10)*, 42 (1992).

Lochhead, R. Y.; "The Role of Surface Active Agents in Formulating Water-Borne Coatings," Plenary Lecture, *Proceedings of the 19th Water-Borne, Higher-Solids, & Powder Coatings Symposium*, New Orleans, LA, p. 1, (February 1992).

Lochhead, R. Y.; A. C. Eachus, K. D. Bremecker; "Alternative Neutralizing Amines for Carbomers,"*Proceedings of the InCosmetics Conference*, Frankfurt, Germany, p. 302, (March 1992).

Lochhead, R. Y.; A. C. Eachus and K. D. Bremecker, "The Evaluation of Alternative Neutralizing Bases for Carbomers,"*Siefen Ohlen Fettewasche, Kosmetikjahrbuch*, Germany, p. 69, (March 1992).

Lochhead, R. Y.; J. R. Wright; L. J. Mathias; "A Direct Real-Time Visual Study of the Morphological Changes in Hair Which Accompany Cosmetic Treatment," (1991).

Lochhead, R. Y.;"The Effects of Mesomorphic Phase Structure on the Efficacy of Skin Moisturizing Lotions," *J. Soc. Cosmetic Chemists*, (1991).

Lochhead, R. Y.; "The Rheology of Hair Care Products,"Chapter 8 in *Rheological Properties of Cosmetics and Toiletries*, D. Laba, Editor, Marcel Dekker, (1991).

Lochhead, R. Y.; "Electrosteric Stabilization of Oil-in-Water Emulsions by Hydrophobically Modified Poly(acrylic acid) Thickeners," chapter in *Polymers as Rheology Modifiers*, ACS Symposium Series #462; D. N. Schulz and J. E. Glass, Editors; American Chemical Society, p. 101, Washington, DC, (1991).

Lochhead, R. Y.; "Hair Gels,"*Household Pers. Prod. Ind.*, *27(4)*, 58, (1990).

Lochhead, R. Y.; J. A. Davidson; G. M. Thomas; "Poly(acrylic acid) Thickeners: The Importance of Gel Microrheology and Evaluation of Hydrophobically Modified Derivatives as Emulsifiers," *Polymers in Aqueous Media: Performance Through Association*, Advances in Chemistry Series #223, p. 113, J. E. Glass, Editor, American Chemical Society: Washington, DC, (1989).

Lochhead, R. Y.; "The History of Polymers in Hair Care (1940-Present)," *Cosmetics and Toiletries, 103(12)*, 25, (1988).

Lochhead, R. Y.; "Encyclopedia of Polymers and Thickeners for Cosmetics," *Cosmetics and Toiletries, 103*, 99, (1988).

Lochhead, R. Y.; W. J. Hemker; J. Y. Castaneda; "Hydrophobically Modified Carbopol Polymers. A New Method for the Rapid Preparation of Storage-Stable Cosmetic Lotions Which Break Upon Skin Contact," *Parfuem. Kosmet., 69(4)*, 218 (1988).

Lochhead, R. Y.;"Probing the Microstructure of Polyelectrolyte Gels, *Polym. Mater. Sci. Eng., 57*, 272, (1987).

Lochhead, R. Y.; W. J. Hemker; J. Y. Castaneda; "Hydrophobically Modified Carbopol Polymers. A New Method for the Rapid Preparation of Storage-Stable Cosmetic Lotions Which Break Upon Skin Contact," *Seifen, Oele, Fette, Wachse, 113(5)*, 149, (1987).

Lochhead, R. Y.; W. J. Hemker; J. Y. Castaneda; "Hydrophobically Modified 'Carbopol' Resins," *Soap, Cosmet., Chem. Spec., 63(5)*, 28, (1987).

Lochhead, R. Y.; W. J. Hemker; J. Y. Castaneda; "Hair Care Gels,"*Cosmetics and Toiletries, 102(10)*, 89, (1987).

Lochhead, R. Y.; W. J. Hemker; J. Y. Castaneda; D. Garlen; "Novel Cosmetic Emulsions," *Cosmetics and Toiletries, 101(11)*, 125 (1986).

Lochhead, R. Y.; D. S. Warfield; C. R. Gasiewski; "Phase Diagrams as a Formulation Guide in Aqueous Polymer/Surfactant Systems," *Polymer Science and Engineering, 25(17)*, 1110, (1985).

Lochhead, R. Y.; "Carbomers as Thickeners and Suspending Agents in Shampoos," *Soap, Cosmet., Chem. Spec., 61(4)*, 46, (1985).

Lochhead, R. Y.; A. M. North; "Dielectric Relaxation in Solutions of Two Poly(alkyl isocyanates)s," *J. Chem. Soc., Faraday Trans. 2, 68(7)*, 1089, (1972).

Lochhead, R. Y.; S. B. Dev; A. M. North; "Dielectric and Viscoelastic Relaxation in Dilute Solutions of Some Non-Gaussian Chains," *Discuss. Faraday Soc., 49*, 244, (1970).

PREPRINTS

Robert Y. Lochhead, "The Use of Polymers in Emulsions", Society of Cosmetic Chemists Annual Scientific Seminar, Anaheim, California, May 10-11, 2007

Robert Y. Lochhead, "Investigation of the Effects of Polymer Microstructure on the Rheologies of Polyelectrolyte Gels", Society of Cosmetic Chemists Annual Scientific Seminar, Anaheim, California, May 10-11, 2007

Robert Y. Lochhead, "Formulating with Combinatorial Techniques for Rapid Innovation," Waterborne Conference, New Orleans, Louisiana, February, 2007.

Robert Y. Lochhead and, Lisa R. Huisinga, "Revolutionary Trends in the Advancement and Integration of Cosmetic Science: Combinatorial Formulation", *Proceedings of the 24th IFSCC Congress, Osaka, Japan;* October, 2006.

Robert Y. Lochhead and Ken Klein, "Advanced Emulsions" Society of Cosmetic Chemists Course, Newark,NJ, March 8-9,2006.

Robert Y. Lochhead and, Lisa R. Huisinga, "A Combinatorial Investigation of the Effects of Order of Addition in the Interaction of Polyelectrolytes with Surfactants", *Preprints of the Waterborne Conference,* New Orleans, February 24, 2006

Robert Y. Lochhead, "The Role of Polymers in Cosmetics: Hair Conditioning and Color", Proceedings of the Advanced Technology Conference, Miami Florida, February6- 7,2006.

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Robert Y. Lochhead, Lisa R. Huisinga, Christina Edwards and Anthony Hill. "A Combinatorial Investigation of the Effects of Order of Addition in the Interaction of Polyelectrolytes with Surfactants", *Preprints of the Society of Cosmetic Chemists, Annual Meeting,* New York, December 2005

Robert Y. Lochhead, Lisa R. Huisinga, Christina Edwards and Anthony Hill. "A Combinatorial Investigation of the Effects of Order of Addition in the Interaction of Polyelectrolytes with Surfactants", *Polym. Prepr. (Am. Chem. Soc., Div. Polym. Chem.)* Fall Meeting, of the American Chemical Society Washington DC. **2005**,

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Robert Y. Lochhead,. "Polymers in Cosmetics: Fall Meeting, Washington DC An Introductory Workshop", *Polym. Prepr. (Am. Chem. Soc., Div. Polym. Chem.)*, Fall Meeting, of the American Chemical Society **2005**,

Laura Silva, Anna Lee Tonkovich, Dongming Qiu, Krissy Pagnotto, Paul Neagle, **Robert Lochhead,** "Enabling Advanced Emulsions in Microchannel Architecture", 7th *World Congress of Chemical Engineering, Glasgow, Scotland,* July 10-14, 2005.

Robert Y. Lochhead, Cynthia A. Welch, "The Effect of Hydrophobically-Modified Amphipathic Polymers on Emulsions Stabilized with Self-Assembled Nanostructure Emulsifiers *Preprints of the 23rd IFSCC Congress, Orlando, October 23-26, 2004.*

Stephen Ray Jones, Virginia Smith, and Robert Y. Lochhead, "Biodegradable Packaging Materials for Cosmetic Applications, *Preprints of the 23rd IFSCC Congress, Orlando, October 23-26, 2004.*

Charles L. McCormick, Kathryn M. Johnson, Michael J. Fevola, and Robert Y.Lochhead,"Hydrophobically Modified Acrylamide-Based Polybetaines: Interaction with Various Small-Molecule Surfactants in Aqueous Solution", *Preprints of the 23rd IFSCC Congress, Orlando, October 23-26, 2004.*

Camille T. Haynes and. Robert Y. Lochhead, "The Investigation of Adsorption, Intercalation and Exfoliation of Montmorillonite by Polyvinylamine and its Hydrophobically modified derivatives" *Preprints of the 23rd IFSCC Congress, Orlando, October 23-26, 2004.*

Lisa Huisinga and Robert Y. Lochhead; "The Development of Combinatorial Methods for Formulation" *Preprints of the 23rd IFSCC Congress, Orlando, October 23-26, 2004.*

Christina Edwards, Xiumie Xun, C.E. Hoyle and Robert Y. Lochhead, "Polymerization of Cubic Liquid Crystal Phase" *Preprints of the 23rd IFSCC Congress, Orlando, October 23-26, 2004.*

Naoya Yamato, Daisuke Kaneko and Robert Y. Lochhead, "The Investigation of Sodium N-Acyl-L-glutamate and Cationic Cellulose Interaction" *Preprints of the 23rd IFSCC Congress, Orlando, October 23-26, 2004.*

Joan B. Schulman and Robert Y. Lochhead, "A Study of the Adsorption of Hydrophobically Modified Polysaccharides onto Hydrophobic Surfaces and Assessment of the Emulsifying Capabilities of this Class of Materials" *Preprints of the 23rd IFSCC Congress, Orlando, October 23-26, 2004.*

Stig E. Friberg and **Robert Y. Lochhead,** 'Emulsions, Microemulsions, Dispersions and Liquid Crystals' Short Course for the American Chemical Society, November 12-14, 2003. Bound Brook, NJ.

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Camille T. Haynes and **Robert Y. Lochhead,** The Investigation of Macromolecular Intrusion of the Interstices of Cosmetically-important Substrates, *Preprints of the Society of Cosmetic Chemists,* National Scientific Meeting, Washington DC, May 8, 2003.

R. Y. Lochhead; "Solution Behavior of Aqueous Solutions of Hydrophobically Modified Polyvinylamine and Dodecyltrimethylammonium Bromide" *Preprints of the Society of Cosmetic Chemists,* National Meeting, Toronto, Canada, May 8, 2000

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Lochhead, R. Y.; C. J. Rulison; "An Investigation of Polyelectrolyte/Nonionic Polymer and Polyelectrolyte/Polyelectrolyte Interaction," SCC National Scientific Seminar, Las Vegas, NV (May 5, 1994).

Lochhead, R. Y.; C. M. Rodgers; "Evaluation of Critical Overlap Concentration for a Series of Polyelectrolytes," SCC National Scientific Seminar, Las Vegas, NV (May 5, 1994).

Lochhead, R. Y.; M. E. Tisack; "The Study of Proteins from Plants and Insects as Candidates for Oil Recovery," SCC National Scientific Seminar, Las Vegas, NV (May 5, 1994).

Lochhead, R. Y.; J. Medley; "Construction of a High Pressure Fully Automated Reactor Suitable for Critical Fluid Experimentation," SCC National Scientific Seminar, Las Vegas, NV (May 5, 1994).

Lochhead, R. Y.; "The Polymer Science Program at the University of Southern Mississippi," ACS Rubber Division Conference, Chicago, IL (April 22, 1994).

Lochhead, R. Y.; H. S. Bui; C. J. Rulison; "The Effect of pH on the Critical Overlap Concentration of Hydrophobically Modified Poly(acrylic acid) Microgels in Aqueous Solution," *Abstracts MAS*, *38*, 36, (1993).

Lochhead, R. Y.; T. T. Nguyen; "The Study of Structure-Building by Polymer/Surfactant Coacervates," *Abstracts MAS*, *38*, 36, (1993).

Lochhead, R. Y.; K. Armstrong; "Study of Structure Building by Polymer/Surfactant Coacervates Using Hydrophobically Modified Cetyltrimethylammonium Chloride," *Abstracts MAS*, *38*, 36, (1993).

Lochhead, R. Y.; K. Light; "The Evaluation of Alternative Neutralizing Bases for Carbomers," *Abstracts MAS*, *38*, 36, (1993).

Lochhead, R. Y.; T. Pierce; "An Evaluation of the Molecular Size and Structure of a Poly(acrylic acid) Thickener,"*Abstracts MAS*, *38*, 37, (1993).

Lochhead, R. Y.; R. West; "The Study of Liquid Crystal Morphology Using Monionic Surfactants in the Presence of Hydrophobically Modified Hydroxyethyl Cellulose," *Abstracts MAS*, *38*, 37, (1993).

Lochhead, R. Y.; D. E. Phillips; "The Role of Alkanolamines as Structure Modifiers in Aqueous Amphipathic Mesomorphic Systems," *Abstracts MAS*, *38*, 37, (1993).

Lochhead, R. Y.; W. Struss; C. J. Rulison; "The Kinetics of Polymer Diffusion to Liquid/Liquid Interfaces by Drop Volume Techniques"" *Abstracts MAS*, *38*, 37, (1993).

Lochhead, R. Y.; C. J. Rulison; P. Higginbotham; C. Fuller; "Polymeric Emulsification and Associative Thickening: Probing the Mechanism of Action of Hydrophobically-Modified Hydroxyethylcellulose and Hydrophobically-Modified Poly(acrylic acid)," *Proceedings of the 20th Water-Borne, Higher-Solids, & Powder Coatings Symposium*, New Orleans, LA (February 23, 1993).

Lochhead, R. Y.; C. J. Rulison; "Effect of pH and Electrolyte Concentration on the Stability of Polymerically Stabilized Emulsion Systems," 204th ACS National Meeting, Washington, DC (August 1992).

Lochhead, R. Y.; P. S. Wolfe; "Polymer-Surfactant Interaction in an Uncharged Polysaccharide-Ammonium Lauryl Sulfate System," *Abstracts MAS*, *37*, (1992).

Lochhead, R. Y.; J. G. Parish; "A Study of the Interaction of an Anionic Surfactant with a Cellulosic Associative Thickener," *Abstracts MAS*, *37*, (1992).

Lochhead, R. Y.; M. M. Ellis; "Phase Behavior of Aqueous Compositions Containing Cationic Hydrophobically-Modified Hydroxyethyl Cellulose and Ammonium Lauryl Sulfate," *Abstracts MAS*, *37*, (1992).

Lochhead, R. Y.; G. A. Brooks; "Investigation of the Interaction Between a Cationically-Charged Hydrophobically-Modified Hydroxyethyl Cellulose," *Abstracts MAS*, *37*, (1992).

Lochhead, R. Y.; A. Wissner; "The Effect of Strong Bases on Human Hair," *Abstracts MAS*, *37*,(1992).

Lochhead, R. Y.; C. J. Rulison; "Investigation of the Interaction of Poly(isopropyl acrylamide) with Alkyl Sulfates in Aqueous Solution," *Abstracts MAS*, *37*, (1992).

Lochhead, R. Y.; D. M. Lindsey; "Polymer-Surfactant Interactions in Potential Bioadhesive Systems,"*Abstracts MAS*, *37*, (1992).

Lochhead, R. Y.; M. Powell; "Investigation of the Effect of the Molecular Structure of Organic Amine Neutralizing Bases on Poly(acrylic acid) Ion Expansion in Aqueous Solution," *Abstracts MAS*, *37*, (1992).

Lochhead, R. Y.; R. Brown; "The Evaluation and Selection of Neutralizers for Poly(acrylic acid) Thickeners," *Abstracts MAS*, *37*, (1992).

Lochhead, R. Y.; G. E. Cooley; "The Evaluation of Alternative Neutralizing Bases for Carbomers: The Effect of Neutral, Ionically-Dissociated Salt,"*Abstracts MAS*, *37*, (1992).

Lochhead, R. Y.; K. M. Gay; "Investigation of the Molecular Adsorption of Surfactant and Hydrophilic Polymer Aqueous Solutions on Glass and Keratin,"*Abstracts MAS*, *37*, (1992).

Lochhead, R. Y.; K. S. Kwan; "Investigating the Use of a Polymeric Emulsifier to Prepare New Low Volatile Organics Aqueous Coatings," *Abstracts MAS*, *37*, (1992).

Lochhead, R. Y.; C. F. Edwards; "Identifying the Interactions Between Sodium Dodecyl Sulfate and Hydroxypropylcellulose,"*Abstracts MAS*, *37*, (1992).

Lochhead, R. Y.; W. R. Fron; "An Investigation of the Effect of the Molecular Structure of Neutralizing Amine on the Efficacy of Carbomers as a Gellant for Hydroalcoholic Systems,"*Abstracts MAS*, *37*, (1992).

PRESENTATIONS

Robert Y. Lochhead, "The Use of Polymers in Emulsions", Society of Cosmetic Chemists Annual Scientific Seminar, Anaheim, California, May 10-11, 2007

Robert Y. Lochhead, "The Use of Polymers in Emulsions", Society of Cosmetic Chemists Annual Scientific Seminar, Anaheim, California, May 10-11, 2007

Robert Y. Lochhead, "Investigation of the Effects of Polymer Microstructure on the Rheologies of Polyelectrolyte Gels", Society of Cosmetic Chemists Annual Scientific Seminar, Anaheim, California, May 10-11, 2007

Mindy Goldstein and **Robert Y. Lochhead;** "Demystifying INCI Nomenclature", Society of Cosmetic Chemists Annual Scientific Seminar, Anaheim, California, May 10-11, 2007

Ashley Cox, Stephen Foster and **Robert Y. Lochhead,** "A study of the fundamental molecular structure/property relationships for alkali swellable thickeners", Society of Cosmetic Chemists Annual Scientific Seminar, Anaheim, California, May 10-11, 2007

Stephen Foster and **Robert Y. Lochhead,** "A study of the role of hydrophobic interaction in molecular structure/property relationships for hydrophobically-modified alkali swellable thickeners", Society of Cosmetic Chemists Annual Scientific Seminar, Anaheim, California, May 10-11, 2007.

Lisa Fike, Nicole McWright and **Robert Y. Lochhead,** "Taking cosmetic science to the school classroom: background science. Investigating the effect of sodium chloride concentration on complex coacervate formation within a concentrated regime", Society of Cosmetic Chemists Annual Scientific Seminar, Anaheim, California, May 10-11, 2007

Nicole McWright, Lisa Fike, and **Robert Y. Lochhead,** "Taking cosmetic science to the school classroom: Implementation. Investigating the effect of sodium chloride concentration on complex coacervate formation within a concentrated regime", Society of Cosmetic Chemists Annual Scientific Seminar, Anaheim, California, May 10-11, 2007

Mindy Goldstein and **Robert Y. Lochhead;** "Demystifying INCI Nomenclature", Society of Cosmetic Chemists Annual Scientific Seminar, Anaheim, California, May 10-11, 2007

Robert Y. Lochhead, "Polymers in Cosmetics", Society of Cosmetic Chemists' Online Course, April 2007.

Robert Y. Lochhead, "Formulating with Combinatorial Techniques for Rapid Innovation," HAPPI Webinar, March 2007.

Robert Y. Lochhead, "Polymer in Cosmetics", Society of Cosmetic Chemists' Online Course, February 2007.

Lisa Fike, Nicole McWright and **Dr. Robert Lochhead,** "Investigating the Effect of Sodium Chloride Concentration on Complex Coacervate Formation within a Concentrated Regime", Mississippi Academy of Sciences, February 2007

Robert Y. Lochhead, "Formulating with Combinatorial Techniques for Rapid Innovation," Waterborne Conference, New Orleans, Louisiana, February, 2007.

Robert Y. Lochhead, "Trends in the Advancement and Integration of Cosmetic Science: Combinatorial Formulation", Keynote Lecture, The 24th IFSCC Congress, Osaka, Japan, Oct 18, 2006.

Lisa R. Huisinga, Robert Y. Lochhead; "An investigation of the effects of order of addition on the mechanism of interaction of polyelectrolyte- surfactant systems in the semi-dilute and concentrated regimes.' The Society of Cosmetic Chemists, National Scientific Seminar, Boston, May, 2006.

Robert Y. Lochhead, "A Polymer Chemist's View Of The Epidermal Barrier", Invited Lecture, Advanced Technology Conference, Barcelona. Spain, 2006.

Robert Y. Lochhead, "Undergraduate Research in Polymer Science", *Am. Chem. Soc,* Spring Meeting, of the American Chemical Society Atlanta. **2006**

Ashley Cox, Christina Edwards, Lauren Goodman, **Robert Y. Lochhead**; "Interaction of hydrolyzed collagen with amphoteric nanoparticles" Spring Meeting, of the American Chemical Society Atlanta. **2006**

Tara C. Waller, Lisa R. Huisinga, **Robert Y.Lochhead**; "Investigation of the polyelectrolyte – association colloid interaction in the semi-dilute and concentrated regime using high-throughput screening",*Abstracts of Am. Chem. Soc,* Spring Meeting, of the American Chemical Society Atlanta. **2006**

Robert Y. Lochhead and Ken Klein, "Advanced Emulsions", Society of Cosmetic Chemists Course, Newark,NJ, March 8-9,2006.

Robert Y. Lochhead and, Lisa R. Huisinga, "A Combinatorial Investigation of the Effects of Order of Addition in the Interaction of Polyelectrolytes with Surfactants", T*he Waterborne Conference,* New Orleans, February 24, 2006

Robert Y. Lochhead, "The Role of Polymers in Cosmetics: Hair Conditioning and Color", Invited Lecture, Advanced Technology Conference, Miami Florida, February 7, 2006.

Robert Y. Lochhead, "The Role of Polymers in Cosmetics: Hair Styling", Invited Lecture, Advanced Technology Conference, Miami Florida, February 6,2006.

Robert Y. Lochhead, Lisa R. Huisinga, "High Throughout Experimentation Techniques to Probe Mechanism and Guide Formulation of Polymer-Surfactant Systems", Invited Lecture; *Royal Society of Chemistry and The Society of Chemical Industry Joint Conference* on *New Developments in Emulsions and Foams,* Manchester, England, December 12-14, 2005.

Robert Y. Lochhead, Lisa R. Huisinga, Christina Edwards and Anthony Hill. "A Combinatorial Investigation of the Effects of Order of Addition in the Interaction of Polyelectrolytes with Surfactants", *The Society of Cosmetic Chemists, Annual Meeting,* New York, December 2005

Robert Y. Lochhead, Lisa R. Huisinga, "The Investigation of the Effects of Polyelectrolyte Structure and Order of Addition in Complex Coacervate Properties using High Throughput Formulation and Characterization Techniques', *The Materials Research Society, Annual Meeting Boston*, November 28 2005

Lisa R Huisinga; **Robert Y. Lochhead**, "Investigation of the Structure of Polyelectrolyte-Based Complex Coacervates and Effects of Electrolyte Order of Addition." Invited Keynote Lecture, NIST Combinatorial Methods Center Workshop on Polymer Formulations, Gaithersburg MD, October 27-28, 2005.

Robert Y Lochhead, "A Polymer Chemist's View of the Epidermal Barrier," Invited Keynote Lecture at the *Gordon Conference on Mammalian Skin, Massachusetts, August 2005.*

Robert Y. Lochhead, Lisa R. Huisinga, Christina Edwards and Anthony Hill. "A Combinatorial Investigation of the Effects of Order of Addition in the Interaction of Polyelectrolytes with Surfactants",*Am. Chem. Soc.,)* Fall Meeting, of the American Chemical Society Washington DC. **2005**,

Robert Y. Lochhead, Lisa R. Huisinga, Christina Edwards and Anthony Hill. "A Combinatorial Investigation of the Effects of Order of Addition in the Interaction of Polyelectrolytes with Surfactants", *Am. Chem. Soc., Div. Polym Materials Science and Engineering*, Fall Meeting, of the American Chemical Society Washington DC. **2005**,

Robert Y. Lochhead,. "Polymers in Cosmetics: Fall Meeting, Washington DC An Introductory Workshop", *Am. Chem. Soc., Div. Polym. Chem.*, Fall Meeting, of the American Chemical Society **2005**,

Laura Silva, Anna Lee Tonkovich, Dongming Qiu, Krissy Pagnotto, Paul Neagle, **Robert Lochhead,** "Enabling Advanced Emulsions in Microchannel Architecture", 7th *World Congress of Chemical Engineering, Glasgow, Scotland*, July 10-14, 2005.

Robert Y. Lochhead,. "The High Throughput Investigation of Polyphenolic Couplers in Biodegradable Packaging Materials," Mississippi Biomass Council Annual Meeting, Jackson , MS, March **2005**,

Lisa Huisinga, Robert Y.Lochhead, '*The Effects of Electrolyte Order of Addition on Oppositely Charged Polymer –Surfactant Coacervate Formation in Concentrated Systems";* Society of Cosmetic Chemists Annual Scientific Conference,Las Vegas,June 2-3,2005

Christina Edwards, Robert Y.Lochhead, '*The Impacts of a Monovalent Electrolyte on Complex Coacervate Formation"* Society of Cosmetic Chemists Annual Scientific Conference,Las Vegas,June 2-3,2005

Tara Waller, Robert Y.Lochhead, '*An Investigation of the Cationic Guar-Anionic Surfactant Interactions in Concentrated Systems";* Society of Cosmetic Chemists Annual Scientific Conference,Las Vegas,June 2-3,2005

Anthony Hill, Robert Y.Lochhead, '*An Investigation of the Effect of Surfactant EO length on Coacervate Formation";* Society of Cosmetic Chemists Annual Scientific Conference,Las Vegas,June 2-3,2005

Ashley Cox, Robert Y.Lochhead, '*A Study of The Wetting and Thermal Properties of Aluminum Soap Films";* Society of Cosmetic Chemists Annual Scientific Conference,Las Vegas,June 2-3,2005

Lauren Goodman, Robert Y.Lochhead, '*The influence of Hydrophobicaly-Modified Hydroxyethyl Cellulose on Lamellat Phase Structures";* Society of Cosmetic Chemists Annual Scientific Conference,Las Vegas,June 2-3,2005

Marsha Cole, Robert Y.Lochhead, '*Investigation of the Effects of Molecular Weight and Hydrophobic Modiffcation on Poly(vinylpyrrolidone) Solubility";* Society of Cosmetic Chemists Annual Scientific Conference,Las Vegas,June 2-3,2005.

Nathaniel Follet,,Robert Y.Lochhead, '*Design of a Stimuli-Responsive Coupler for a Smart Biodegradable Nanocomposite"* Society of Cosmetic Chemists Annual Scientific Conference,Las Vegas,June 2-3,2005.

Robert Y. Lochhead, 'Recent Advances of Polymers in Cosmetics', Invited Keynote Lecture, Advanced Technology Conference, Berlin, April 2005.

RobertY.Lochhead, Stephen R.Jones, VirginiaSmith, Invited Lecture,*"The High Throughput Investigation of Polyphenolic Couplers in Biodegradable Packaging Materials"* The Third Japan-U.S.Workshop on Combinatorial Materials Science and Technology, Okinawa, Japan, December 7-10 2004

Robert Y. Lochhead, Cynthia A. Welch, "The Effect of Hydrophobically-Modified Amphipathic Polymers on Emulsions Stabilized with Self-Assembled Nanostructure Emulsifiers, *23rd IFSCC Congress, Orlando, October 23-26, 2004.*

Stephen Ray Jones, Virginia Smith, and **Robert Y. Lochhead,** "Biodegradable Packaging Materials for Cosmetic Applications, *23rd IFSCC Congress, Orlando, October 23-26, 2004.*

Charles L. McCormick, Kathryn M. Johnson, Michael J. Fevola, and **Robert Y. Lochhead**,"Hydrophobically-Modified Acrylamide-Based Polybetaines: Interaction with Various Small-Molecule Surfactants in Aqueous Solution", *23rd IFSCC Congress, Orlando, October 23-26, 2004.*

Camille T. Haynes and. **Robert Y. Lochhead**, "The Investigation of Adsorption, Intercalation and Exfoliation of Montmorillonite by Polyvinylamine and its Hydrophobically modified derivatives" *Preprints of the 23rd IFSCC Congress, Orlando, October 23-26, 2004.*

Lisa Huisinga and **Robert Y. Lochhead**; "The Development of Combinatorial Methods for Formulation" *23rd IFSCC Congress, Orlando, October 23-26, 2004.*

Christina Edwards, Xiumie Xun, C.E. Hoyle and **Robert Y. Lochhead**, "Polymerization of Cubic Liquid Crystal Phase" *23rd IFSCC Congress, Orlando, October 23-26, 2004.*

Naoya Yamato, Daisuke Kaneko and **Robert Y. Lochhead**, "The Investigation of Sodium N-Acyl-L-glutamate and Cationic Cellulose Interaction" *23rd IFSCC Congress, Orlando, October 23-26, 2004.*

Joan B. Schulman and **Robert Y. Lochhead**, "A Study of the Adsorption of Hydrophobically Modified Polysaccharides onto Hydrophobic Surfaces and Assessment of the Emulsifying Capabilities of this Class of Materials" *23rd IFSCC Congress, Orlando, October 23-26, 2004.*

Stig E. Friberg and **Robert Y. Lochhead**, 'Emulsions, Microemulsions, Dispersions and Liquid Crystals' Short Course for the American Chemical Society, 228th ACS National Meeting, Philadelphia. PA, 2004

Lochhead, R.Y. Polymers in Cosmetics: Recent Advances, Ciba Corporation, Bradford, England, September 24, 2004.

Lochhead, R.Y. Polymers in Cosmetics: Recent Advances, Noveon Corporation, Brecksville, OH,, June 23, 2004.

Lochhead, R.Y.; McConnell-Boykin, C.L.; Jarrett, W.; Haynes, C. T.;Interaction of Hydrophilic and hydrophobically modified polyelectrolytes with smectite clays, International Polyelectrolytes Conference, The University of Massachusetts at Amherst, May 16, 2004.

Lochhead, R.Y. Continuing Education Course on the role of polymers in cosmetic formulations, Society of Cosmetic Chemists', North Carolina State University, May 15, 2004.

Lochhead, R.Y. Continuing Education Course on Hair Technology, Wilmington, DE, May 3, 2004.

Lochhead, R.Y. Polymers in Cosmetics: Recent Advances, Ciba Corporation, Tarrytown, N.Y.,May 26, 2004.

Lochhead, R.Y.;; "Why Liquid Crystals are our Friends', Invited lecture, Society of Cosmetic Chemists' Annual Scientific Seminar, May 5, 2004

Xun, Xiumei ; **Lochhead, R.Y**; Nano-assembles by directed synthesis in cubic lyotropic mesophases, Society of Cosmetic Chemists' Annual Scientific Seminar, May 5, 2004

Deepak, Rahil; **Lochhead, R.Y.**; Towards an Understanding of Complex Stimuli Responsive Formulations , Society of Cosmetic Chemists' Annual Scientific Seminar, May 5, 2004

Edwards, C; **Lochhead, R.Y.;** Towards an Understanding of Complex Stimuli Responsive Formulations , Society of Cosmetic Chemists' Annual Scientific Seminar, May 5, 2004

Jones, S.R.; **Lochhead, R.Y** ;Towards the Design of Biodegradable Packaging Materials for Cosmetic Applications, Society of Cosmetic Chemists' Annual Scientific Seminar, May 5, 2004

Huisinga, L.R.; **Lochhead, R.Y;** The Development of Combinatorial Methods for Formulation of Polyelectrolyte-based Complex Coacervates, Society of Cosmetic Chemists' Annual Scientific Seminar, May 5, 2004

Smith, V: **Lochhead, R.Y.** ; Formation of Biodegradable Composites for Packaging Applications, Society of Cosmetic Chemists' Annual Scientific Seminar, May 5, 2004

DeLaine, A; **Lochhead, R.Y.**; Component interactions for biodegradable nanocomposites, Society of Cosmetic Chemists' Annual Scientific Seminar, May 5, 2004

Lochhead, R.Y.; Klein, K. ; Advanced Emulsions Short Course, Society of Cosmetic Chemists' Annual Scientific Seminar, May 5, 2004

Lochhead, R.Y.;; "Why Liquid Crystals are our Friends', Invited lecture, Society of Cosmetic Chemists' Annual Scientific Seminar, May 5, 2004

Lochhead, R.Y.; Polymer. Montmorillonite Interaction, Southern Clay Products, Gonzales, TX, April 20,2004

Lochhead, R.Y.; Introducing New Materials to Cosmetics: Case Studies, Society of Cosmetic Chemists, Memphis, April 14, 2004

Huisinga, L.R.; **Lochhead, R.Y.;** Welch, C; Maggio, S; McKay, T;"The development of combinatorial methods for formulation of polymer surfactant systems", Abstracts of Papers, 227th ACS National Meeting, Anaheim, CA, 2004

Friberg, S.E.; **Lochhead, R.Y.;** Welch, C; "An investigation of the interaction of hydrophobically modified hydroxyethylcellulose with lamellar and hexagonal lyotropic liquid crystal phases, Abstracts of Papers, 227th ACS National Meeting, Anaheim, CA, 2004

Lochhead, R.Y.;. Schumann J.B.; A study of the adsorption of hydrophobically modified dextrin at the oil/ water interface, Abstracts of Papers, 227th ACS National Meeting, Anaheim, CA, 2004,

Haynes, C.A.; **Lochhead, R.Y.;** The investigation of macromolecular intrusion of nanoscale interstices, Abstracts of Papers, 227th ACS National Meeting, Anaheim, CA, 2004

Stig E. Friberg and **Robert Y. Lochhead,** 'Emulsions, Microemulsions, Dispersions and Liquid Crystals' Short Course for the American Chemical Society, November 12-14, 2003 Bound Brook, NJ.

Robert Y. Lochhead, Expert Level Haircare, Short course for the Society of Cosmetic Chemists, Chicago, IL, November 7, 2003

Robert Y. Lochhead, 'Emulsions, Microemulsions, Dispersions and Liquid Crystals' Short Course for the Wrigley Company, November 6, Chicago, IL.

Lisa R. Huisinga and **Robert Y. Lochhead**, Investigation of the structure of polyelectrolyte-based complex coacervates, 226th National Meeting of the American Chemical Society New York, NY, Sept. 7-11, 2003.

Kyle M. Price, Camille T. Haynes and **Robert Y. Lochhead,** Polymer-particle interactions in aqueous systems: poly-N-vinylformamide, polyvinylamine, its derivatives and montmorillonite, 226th National Meeting of the American Chemical Society New York, NY, Sept. 7-11, 2003.

Naoya Yamato, Daisuke Kaneko and **Robert Y. Lochhead,** The Investigation of Sodium N-Acyl-L-glutamate and Cationic Cellulose Interaction, 226th National Meeting of the American Chemical Society New York, NY, Sept. 7-11, 2003.

Cynthia F. Welch and **Robert Y. Lochhead,** The Effect of Hydrophobically-Modified Hydroxyethylcellulose on the Structure and Rheology of a Model Surfactant System in the Liquid Crystal Regime, , 226th National Meeting of the American Chemical Society New York, NY, Sept. 7-11, 2003.

Camille T. Haynes and **Robert Y. Lochhead,** The Investigation of Macromolecular Intrusion of the Interstices of Cosmetically-important Substrates, 226th National Meeting of the American Chemical Society New York, NY, Sept. 7-11, 2003.

Lisa R. Huisinga and **Robert Y. Lochhead**, Investigation of the structure of polyelectrolyte-based complex coacervates, National Scientific Meeting of the Society of Cosmetic Chemists, May 8, 2003, Washington DC.

Camille T. Haynes and **Robert Y. Lochhead,** The Investigation of Macromolecular Intrusion of the Interstices of Cosmetically-important Substrates, *Society of Cosmetic Chemists,* National Scientific Meeting, Washington DC, May 8, 2003.

Lisa Huisinga and **Robert Y. Lochhead**, "Investigation of the structure of polyelectrolyte-based complex coacervates", 225TH National Meeting of the American Chemical Society, March 24, 2003

Shelley Gallender and **Robert Y. Lochhead,** "An investigation of the emulsifying capabilities of amphipathic titanium dioxide particles" , 225TH National Meeting of the American Chemical Society, March 24, 2003

Camille T Haynes and **Robert Y.** Lochhead, " Interactions of model water-soluble polymers at montmorillonite surfaces," 225TH National Meeting of the American Chemical Society, March 24, 2003

.R.Y.Lochhead, 'An Overview of Water Soluble Polymers", The Procter & Gamble Community of Practice Symposium, Rusham Park, Egham, England , March 13, 2003

R.Y.Lochhead, 'The Role of Polymeric Thickeners in Skin Care Emulsions", The Procter &Gamble Community of Practice Symposium, Rusham Park, Egham, England , March 14, 2003

R.Y.Lochhead, 'The Intrusion of Polymers into Nanospaces", The Procter &Gamble Community of Practice Symposium, Schwalbach, Germany, March 11, 2003

R.Y.Lochhead, 'Wetting, Spreading and Molecular Adhesion to Polmer Substrates", The Procter &Gamble Community of Practice Symposium, Schwalbach, Germany, March 11, 2003

R.Y.Lochhead, 'Conditioning Polymers", The Procter &Gamble Community of Practice Symposium, Schwalbach, Germany, March 10, 2003

R.Y.Lochhead, 'Hairspray Polymere", The Procter &Gamble Community of Practice Symposium, Schwalbach, Germany, March 10, 2003

R.Y.Lochhead, 'Polymers in Cosmetics", The Procter &Gamble Community of Practice Symposium, Schwalbach, Germany, March 10, 2003.

R.Y.Lochhead, 'Latex Selection in Waterborne Coatings", Waterborne Symposium, New Orleans, LA, February 23-25, 2003.

R.Y.Lochhead, 'The Selection of Associative Thickeners", Waterborne Symposium, New Orleans, LA, February 23-25, 2003.

R.Y.Lochhead, 'Practical Applications of Water-soluble Polymers", Waterborne Symposium, New Orleans, LA, February 23-25, 2003.

R.Y.Lochhead, 'The Physical Principles of Formulation", Waterborne Symposium, New Orleans, LA, February 23-25, 2003.

R.Y.Lochhead, ' Formulation: where we've been and where we are going", SCC, West Orange, NJ, October 2, 2002. This won the best presentation award for the year 2002.

R.Y.Lochhead and C.T. Haynes, " Designing Couplers for nanocomposites: the role of polymer adsorption", 224th ACS National Meeting , Boston, August 22, 2002

C.T. Haynes and **R.Y.Lochhead,** "Interactions of watersoluble polymers with montmorillonite clay for biodegradable nanocomposite applications", 224th ACS National Meeting , Boston, August 21, 2002

S.R. .Jones and **R.Y.Lochhead,** "Blends of polycaprolactone and poly(vinylphenol) and its low molecular weight model, phenol: Hydrogen-bond formation. ", 224th ACS National Meeting , Boston, August 20, 2002

A.M. Urbam, C.T. Haynes and **R.Y.Lochhead,** "Adsorption of hydrophobically-modified poly(vinylamine) derivatives to montmorillonite", 224th ACS National Meeting , Boston, August 19, 2002

C.T. Haynes and **R.Y.Lochhead,** " Investigations of water-soluble polymer adsorption to montmorillonite clay as a function of solution pH", 224th ACS National Meeting , Boston, August 18, 2002

R.Y. Lochhead, "Nanostructural Considerations in the Formulation of Liquids and Gels", Global e-lecture, The Procter & Gamble Company, June 2002.

R.Y.Lochhead; " An Introduction to Surfactants for Chemists", University of Southern Mississippi Short Course, June 11, 2002.

S.R. Jones and **R.Y. Lochhead,** "Higher Performance Biodegradable Polymeric Materials: Blends of poly(6-caprolactone) with both poly(vinylphenol) and its low molecular weight model, phenol: Hydrogen Bond Formation", Presented at the Society of Cosmetic Chemists Annual Scientific Seminar, San Antonio, TX, May 9, 2002. **This won the best student presentation award.**

C.T. Haynes and **R.Y. Lochhead,** "Investigation of Macromolecular Intrusion of the Interstices of Cosmetically-Important Substrates", Presented at the Society of Cosmetic Chemists Annual Scientific Seminar, San Antonio, TX, May 9, 2002.

R.Y. Lochhead and K. Klein (Cosmetech), "How to set up a modern formulation laboratory", Presented at the Society of Cosmetic Chemists Annual Scientific Seminar, San Antonio, TX, May 9, 2002.

R.Y. Lochhead, "Frontiers in Equipment", Presented at the Society of Cosmetic Chemists Annual Scientific Seminar, San Antonio, TX, May 9, 2002.

R.Y. Lochhead, "Water Soluble Polymers –2 Day Course", Xavier University, Procter &Gamble, Cincinnati, Ohio, March 21-22, 2002.

R.Y.Lochhead, "Latex Selection in Formulating Waterborne Coatings", Reformulating Short Course, Symposium on waterborne, High Solids and Powder Coatings, New Orleans Feb 5, 2002.

R.Y. Lochhead, " Hydrophilic Polymer Rheology Modifiers and their Role in Personal Care Formulation", Plenary Lecture, The Procter &Gamble Technology Conference, January 29, 2002.

R.Y. Lochhead, "Polymer Surfactant Interaction", Presented at the "Physical Principles of Formulation" New Orleans, LA, , 2001

R.Y. Lochhead, "An Introduction to Associative Thickeners" Presented at the "Modern Coatings" New Orleans, LA, , 2001.

R.Y. Lochhead, "Formulating with Associative Thickeners, Presented at the "Reformulating for Waterborne" New Orleans, LA, 2001. R.Y. Lochhead, K. Klein; "*Emulsions Short Course*", Society of Cosmetic Chemists, Newark, New Jersey, July 17, 2001

R.Y. Lochhead; "*Principles of Polymer Science for Formulators*", Society of Cosmetic Chemists, Newark, New Jersey, July 19, 2001

R.Y. Lochhead; "Surfactants and Emulsions" Thetadyne Course, Charlotte, NC, May 8, 2000

R.Y. Lochhead; C.F. Welch; "Effect of Hydrophobically-Modified Hydroxyethylcellulose on the Phase Morphology of a Model Surfactant Mesophases System in the Liquid Crystal Regime, *Fall Meeting of the American Chemical Society, Chicago*; 2001.

R.Y. Lochhead; C.L. McConnell- Boykin; C. Haynes; "Interaction of Hydrophilic Polymers with Smectite Clays, *Fall Meeting of the American Chemical Society, Chicago*; 2001.

R.Y. Lochhead; T.L. McKay; "Behavior of Mixtures of Poloxamers and Alkyl Sulfates in Lyotropic Liquid Crystalline Phases, *222nd ACS National Meeting, Chicago Illinois, Abstracts of the Division of Colloid and Surface Chemistry*, August 26-30, 2001;.

C.T. Haynes; **R.Y. Lochhead**;"Probing the Interactions of Model Polyelectrolytes and Montmorillonite Clay, *222nd ACS National Meeting, Chicago Illinois, Abstracts of the Division of Colloid and Surface Chemistry*, August 26-30, 2001;

R.Y. Lochhead; C.F. Welch; "Effect of Hydrophobically-Modified Hydroxyethylcellulose on the Phase Morphology of a Model Surfactant Mesophases System in the Liquid Crystal Regime, *222nd ACS National Meeting, Chicago Illinois, Abstracts of the Division of Colloid and Surface Chemistry*, August 26-30, 2001;

R.Y. Lochhead, K. Klein; "*Emulsions Short Course*", Society of Cosmetic Chemists, Montreal, Canada, September 10, 2001

R.Y. Lochhead; *"Fundamentals of Interface Adhesion: Recent Advances in Methodology and Measurement",* Plenary Lecture, Annual Conference of the Adhesives and Sealants Council, New Orleans, October 23, 2001.

Yamato, N.; D. Kaneko; **R. Y. Lochhead**; "The Investigation of Sodium L-Acyl-N-Glutamate/Cationic Cellulose Interaction," *Proceedings of the International Conference on Colloid and Surface Science,* Tokyo, Japan, November 5-8, 2000.

Lochhead, R. Y.; "The Role of Polymer-Surfactant Interaction in the Formation of Stable Lyotropic Surfactant Mesophases and Stablization of Oil-in Water Emulsions," JOCS/AOCS World Congress, Kyoto Japan, (October 22-25, 2000).

Lochhead, R. Y.; C. Welch; "The Effect of Hydrophobically-Modified Hydroxyethylcellulose on the Structure and Rheology of a Model Surfactant System in the Liquid Crystal Regime," *Formulations Forum 2000*, The Association of Formulation Chemists, September 2000.

Robert Y. Lochhead, "Polymers in the Materials Curriculum", Gordon Research Conference on Materials Education, Plymouth, NH, August 1, 2000

Nad'a Spisakova, **Robert Y. Lochhead** and Stacey V. Maggio; "The solution behavior of hydrophobically modified polyvinylamine and dodecyltrimethylammonium bromide, ACS International Colloid Meeting,, Lehigh, PA, July 2000

Robert Y. Lochhead and Tonya L. McKay, "Behavior in Mixtures of Poloxamers and Alkyl Sulfates and Sulfosuccinates in Lyotropic Liquid Crystalline Phases", ACS International Colloid Meeting,, Lehigh, PA, July 2000

Robert Y. Lochhead and Cynthia F. Welch, "The Effect of Hydrophobically-Modified Hydroxyethylcellulose on the Structure and Rheology of a Model Surfactant System in the Liquid Crystal Regime" ACS International Colloid Meeting,, Lehigh, PA, July 2000

R.Y. Lochhead and Cynthia Welch, "The Influence of Hydrophobically Modified Hydroxyethylcellulose on the Structure and Rheology of a Model Surfactant System in the Liquid Crystal Regime", ACS International Colloid Meeting,, Lehigh, PA, July 2000

R.Y. Lochhead, and McConnell-Boykin, C.L.; "An Investigative Study of Polymer Adsorption to Montmorillonite" ACS International Colloid Meeting,, Lehigh, PA, July 2000

R.Y. Lochhead; " Emulsions" Society of Cosmetic Chemists, Newark, NJ, Jume 7-8, 2000

R. Y. Lochhead; "Solution Behavior of Aqueous Solutions of Hydrophobically Modified Polyvinylamine and Dodecyltrimethylammonium Bromide" Society of Cosmetic Chemists, National Meeting, Toronto, Canada, May 8, 2000

Yamato, N.; R. Boudreaux; **R. Y. Lochhead**; "The Investigation of Sodium L-Acyl-N-Glutamate/Cationic Cellulose Interaction," Society of Cosmetic Chemists, National Meeting, Toronto, Canada, May 8, 2000

R.Y. Lochhead; "Surfactants and Emulsions" Thetadyne Course, Charlotte, NC, May 2, 2000

Tisack-Kathman, M.; C. L. McCormick; G. C. Cannon; **R. Y. Lochhead**; "Polymeric Emulsifiers: Seeking the Answer to Molecular Fabrication by Probing Nature's Secrets," ACS Division of Colloid and Surface Chemistry, 219th ACS National Meeting, San Francisco, CA, March 2000.

R.Y. Lochhead; "Polymers at the University of Southern Mississippi" ACS Chemical Education Division, 219th ACS National Meeting, San Francisco, CA, March 2000

R.Y. Lochhead, and McConnell-Boykin, C.L.; "An Investigative Study of Polymer Adsorption to Montmorillonite in Coupling Nanocomposites" ACS PMSE Division, 219th ACS National Meeting, San Francisco, CA, March 2000

R.Y. Lochhead, and McConnell-Boykin, C.L.; "An Investigative Study of Polymer Adsorption to Clay" ACS PMSE Division, 219th ACS National Meeting, San Francisco, CA, March 2000

R.Y. Lochhead, "Polymer Association" Presented at the "Waterborne and Watersoluble Polymers", LA, March 7, 2000.

R.Y. Lochhead, "Formulating with Associative Thickeners, Presented at the "Reformulating for Waterborne" New Orleans, LA, March 7, 2000.

R.Y. Lochhead, "An Introduction to Associative Thickeners" Presented at the "Modern Coatings" New Orleans, LA, March 6, 2000.

R.Y. Lochhead, "Polymer and Particle Dispersions' Presented at the "physical Principles of Formulation" New Orleans, LA, March 5, 2000.

R.Y. Lochhead and Cynthia Welch, "The Influence of Hydrophobically Modified Hydroxyethylcellulose on the Structure and Rheology of a Model Surfactant System in the Liquid Crystal Regime", Roger Porter Memorial Symposium, Asilomar Conference, CA, February 6, 2000

R.Y. Lochhead, "Roger Porter's Influence on the University of Southern Mississippi,"Roger Porter Memorial Symposium, Asilomar Conference, CA, February 6, 2000

Cynthia F. Welch and **Robert Y. Lochhead** The Effect of Hydrophobically-Modified Hydroxyethylcellulose on the Structure and Rheology of a Model Surfactant System in the Liquid Crystal Regime", Society of Cosmetic Chemists Annual Scientific Meeting, New York, NY (1999).

Lochhead, R. Y.; "Polymer Complex Formulation and the Fundamentals of Polymer Surfactant Interaction," The Physical Principles of Formulating with Polymer Solutions and Blends Short Course, New Orleans, LA (February 1999).

Lochhead, R. Y.; "Stability of Latex," Practical Emulsion Polymerization Short Course, New Orleans, LA (February 1999).

Lochhead, R. Y.; "Selection of Associative Thickeners," Modern Coatings Technology Short Course, New Orleans, LA (February 1999).

Lochhead, R. Y.; "New Technology for Skin, Hair, and Fragrance," Spring Educational Seminar, Society of Cosmetic Chemists, New York, (April 1999). Invited Plenary Lecture

Lochhead, R. Y.; R. Boudreaux; S. Maggio; "Phase Behavior of Hydrophobically Modified Polyelectrolyte/Surfactant System," Society of Cosmetic Chemists Annual Scientific Seminar, Chicago, IL (May 5-7, 1999).

Lochhead, R. Y.; A. Marks; C. M. Boykin; "Copolymer Adsorption onto Montmorillionite Clay," Society of Cosmetic Chemists Annual Scientific Seminar, Chicago, IL (May 5-7, 1999).

Lochhead, R. Y.; D. Presken; S. Maggio; "Viscosity Studies of Surfactants on Hydrophobically Modified Polyelectrolyte Solutions," Society of Cosmetic Chemists Annual Scientific Seminar, Chicago, IL (May 5-7, 1999).

Lochhead, R. Y.; "Polymeric Emulsifiers," Omni-Tech International, Philadelphia, PA (1998).

Manuszak-Guerrini, M.; **R. Y. Lochhead**; W. H. Daly; "Structure and Properties of Quaternary Ammonium Cellulose Derivatives," American Chemical Society, Division of Polymeric Materials: Science and Engineering (PMSE), Boston, MA, (1998).

McConnell-Boykin, C.; **R. Y. Lochhead**; "Determining the Nature of Clay/Polymer Interactions," American Chemical Society, Colloid and Surface Science Division, Boston, MA (1998).

McConnell-Boykin, C.; **R. Y. Lochhead**; "Investigating the Bound Fraction of Polyacrylamide Copolymers Adsorbed onto Montmorillonite Clay," American Chemical Society, Colloid and Surface Science Division, Boston, MA (1998). *National Best Paper Award*

Schuman, J.; **R. Y. Lochhead**; "Properties of Hydrophobically Modified Polysaccharides," American Chemical Society, Colloid and Surface Science Division, Boston, MA (1998).

Lochhead, R. Y.; "Understanding the Mechnism of Polymeric Emulsifiers," IBC's International Conference on Surfactants, Short Hills, NJ, (1998).

Maggio, S.; **R. Y. Lochhead**; "pH Effects on the Phase Behavior of Dodetyltrimethylammonium Bromide and Polyvinylamine Solutions," American Chemical Society, Colloid and Surface Science Symposium, Pennsylvania State University, (1998).

McConnell-Boykin, C; **R. Y. Lochhead**; "Exploring the Nature of Polymer Adsorption onto Clay Surfaces Using Infrared Spectroscopy," American Chemical Society, Colloid and Surface Science Symposium, Pennsylvania State University, (1998).

Maggio, S.; **R. Y. Lochhead**; "pH Effects on the Phase Behavior of Dodetyltrimethylammonium Bromide and Polyvinylamine Solutions," Society of Cosmetic Chemists, Seattle, WA (1998). *National Best Paper Award*

Lochhead, R. Y.; "Applications of Water-Soluble and Swellable Polymers/Colloidal Protection, Flocculation, Absorption, and Adhesion," Water-Soluble/Water-Borne Polymers Short Course, New Orleans, LA (1998).

Lochhead, R. Y.; "Selection of Associative Thickeners," Modern Coatings Technology Short Course, New Orleans, LA (1998)

Lochhead, R. Y.; "Stability of Latex," Practical Emulsion Polymerization Short Course, New Orleans, LA (1998).

Lochhead, R. Y.; "Surfactant Micelles, Liquid Crystals and Structured Liquids," The Physical Principles of Formulation, Part II: Formulating with Surfactants Short Course, New Orleans, LA (1998).

Lochhead, R. Y.; "Wetting, Spreading and Adhesion-The Science of Interfaces," The Physical Principles of Formulation, Part II: Formulating with Surfactants Short Course, New Orleans, LA (1998).

Lochhead, R. Y.; "Hair Spray Resins of the Future," Advanced Technology Conference, Miami, FL (1998)

Lochhead, R. Y.; C. McConnell; "The Interaction of Ionic and Nonionic Water-Soluble Polymers with Sodium Montmorillonite," American Chemical Society, Las Vegas, NV (1997).

Lochhead, R. Y.; S. V. Maggio; "Polymer-Surfactqnt Interaction in the Concentrated Regime," American Chemical Society, Las Vegas, NV (1997).

Lochhead, R. Y.; M. Tisack; "Apolipophoren - Nature's Emulsifiers," American Chemical Society, San Francisco, CA (1997).

Lochhead, R. Y.; C. McConnell; "The Interaction of Water-Soluble Polymers with Sodium Montmorillonite," American Chemical Society, San Francisco, CA (1997).

Lochhead, R. Y.; C. McConnell; "Clay-Polymer Interaction," Society of Cosmetic Chemists, Nashville, TN (May 1997).

Lochhead, R. Y.; S. V. Maggio; "Poly(vinylanine) Interaction with Cationic Surfactants," Society of Cosmetic Chemists, Nashville, TN (May 1997)

Lochhead, R. Y.; T. McKay; "Mesomorphic Phase Diagrams for the Terinary System Dodecanoic Acid/Water/Poloxamer," Society of Cosmetic Chemists, Nashville, TN (May 1997).

Lochhead, R. Y.; J. Schuman; "An Evaluation of Hydrophobically Modified Hydroxyethylcellulose as an Emulsion Stabilizer," Society of Cosmetic Chemists, Nashville, TN (May 1997).

Lochhead, R. Y.; M. Tisack; "The Evaluation of Apolipophorins as Oil/Water Emulsifiers," Society of Cosmetic Chemists, Nashville, TN (May, 1997). *Best Poster Award*

Lochhead, R. Y.; "Hair Fixative Polymers," at Advanced Technology Conference, Düsseldorf, Germany. (May 3, 1997).

Lochhead, R. Y.; "The Effect of Polyelectrolyte Microstructure on Ion Association Properties," American Chemical Society National Meeting, Las Vegas, NV (September 9, 1997).

Lochhead, R. Y.; Formulations Forum '97, (September, 1997).

Lochhead, R. Y.; "Emulsions," at Society of Cosmetic Chemists Annual Conference, New York, NY. (December 3, 1997)

Lochhead, R. Y.; "Expert Hair Care," Short Course for the Society of Cosmetic Chemists, New York, NY (November 8, 1996)

Manuszak-Guerrini, M.; **R. Y. Lochhead**; L. Smith-Wright; W. H. Daly; "Structure Elucidation of Complexes of Aminoalkylcarbamoyl Cellulosics and Oppositely Charged Mixed Micelles," Society of Cosmetic Chemists Annual Scientific Seminar, Boston, MA (May, 1996).

Shannon, P.; **R. Y. Lochhead**; "^{23}Na NMR Study of Microstructural Effects on Aqueous Polyacid-Polybase Complexation," Society of Cosmetic Chemists Annual Scientific Seminar, Boston, MA (May, 1996). *Shaw Mudge Best Paper Award*

McKay, T.; **R. Y. Lochhead**; "Morphology of ABA Block Copolymers n Aqueous Solution, As Influenced by the Addition of Ionic Cosurfactants," Society of Cosmetic Chemists Annual Scientific Seminar, Boston, MA (May, 1996).

Armstrong, K.; **R. Y. Lochhead**; "Protein Adsorption at the Oil/Water Interface: Marine Protein," Society of Cosmetic Chemists Annual Scientific Seminar, Boston, MA (May, 1996).

Lochhead, R. Y.; "Industry-University Interaction," Polymer Science Industrial Advisory Committee, Hattiesburg, MS, (April 12, 1996).

Lochhead, R. Y.; K. Klein; "Advanced Emulsion Technology," Society of Cosmetic Chemists Continuing Education Program, Marina Del Rey, CA (April 1-2, 1996).

McConnell, C.; **Lochhead, R. Y.**; "An Investigative Study of Polymer Adsorption onto Montmorillonite Clay," ACS National Meeting, New Orleans, LA, (March 1996).

Lochhead, R. Y.; "University-Industry Interactions," ACS National Meeting, Plenary Presentation, New Orleans, LA, (March 1996).

P. Shannon; **R. Y. Lochhead**; "Polyacid Microstructural Effects in Complexation with Poly(vinyl pyrrolidone)," ACS National Meeting, New Orleans, LA, (March 1996).

Manuszak-Guerrini, M.; **R. Y. Lochhead**; L. Smith-Wright; W. H. Daly; "Structure Elucidation of Complexes of Aminoalkylcarbamoyl Cellulosics and Oppositely Charged Mixed Micelles," ACS National Meeting, New Orleans, LA, (March 1996).

Welch, C. E.; **R. Y. Lochhead**; "Investigations of Bicontinuous Cubic Liquid Crystalline Phases," ACS National Meeting, New Orleans, LA (March 1996).

Schuman, J. B.; **R. Y. Lochhead**; "Oil-water Emulsification Efficacy of Hydrophobically Modified Amylose, Glycogen, and Dextran," ACS National Meeting, New Orleans, LA (March 1996).

McKay, T. L.; **R. Y. Lochhead**; "Liquid Crystalline Behavior of Poly(ethylene oxide)-poly(propylene oxide)-poly(ethylene oxide) Triblock Copolymers in Aqueous Solution, as Influenced by Small-Molecule Cosurfactants," ACS National Meeting, New Orleans, LA (March 1996).

Lochhead, R. Y.; "The Principles of Formulating with Surfactants," in short course: "The Physical Principles of Formulation," held with the 23rd Waterborne, High Solids & Powder Coatings Symposium, New Orleans, LA, (February 1996).

Lochhead, R. Y.; "Phase Diagrams Formulation Guides," in short course: "The Physical Principles of Formulation," held with the 23rd Waterborne, High Solids & Powder Coatings Symposium, New Orleans, LA, (February 1996).

Lochhead, R. Y.; "Polymer Blends," in short course: "The Physical Principles of Formulation," held with the 23rd Waterborne, High Solids & Powder Coatings Symposium, New Orleans, LA, (February 1996).

Lochhead, R. Y.; "Nanostructured Materials," in short course: "The Physical Principles of Formulation," held with the 23rd Waterborne, High Solids & Powder Coatings Symposium, New Orleans, LA, (February 1996).

Lochhead, R. Y.; "Mesomorphic Structures in Polymers," in short course: "The Physical Principles of Formulation," held with the 23rd Waterborne, High Solids & Powder Coatings Symposium, New Orleans, LA, (February 1996).

Armstrong, K.; J. Lamonte; **R. Y. Lochhead**; "The Study of the Mechanism of Hair Cleaners and Conditioners," Mississippi Academy of Sciences, Jackson, MS, (February 23, 1996).

Robbins, E. M.; **R. Y. Lochhead**; "An Investigation of Hydrophobically-Modified Starches for Use as Polymeric Emulsifiers," Mississippi Academy of Sciences, Jackson, MS, (February 22, 1996).

Sanford, W.; M. Tisack; **R. Y. Lochhead**; R. Bateman; "Emulsification Properties of Menhaden Fish Protein," Mississippi Academy of Sciences, Jackson, MS (February 22, 1996).

Lochhead, R. Y.; Rheox Corp. - "The Importance of Mesomorphic Structure in Polymer Solutions" Jan. 1996.

Lochhead, R . Y.; C. J. Rulison; "The Effect of Diffusion of Macromolecular Emulsifiers on Interfacial Adsorption," ACS-Colloid & Surface Science Meeting, Utah, (June 1995).

Lochhead, R. Y.; "Polymeric Emulsifiers," OCAC Seminar, (May 26, 1995).

Lochhead, R. Y.; C. J. Rulison; M. E. Tisack; "The Mechanism of Microgel Polymeric Emulsifiers," SCC Annual Scientific Seminar, Cleveland, OH (May 5, 1995). *Shaw Mudge Best Paper Award*

Lochhead, R. Y.; S. D. Villafanez; "The Micellar Aggregation of Associating Polymers," SCC Annual Scientific Seminar, Cleveland, OH (May 5, 1995). (Invited Paper)

Lochhead, R. Y.; C. McConnell; "An Investigative Study of Polyelectrolytes Adsorbed to Montmorillonite Clay for Rheological Control of Aqueous Systems," SCC Annual Scientific Seminar, Cleveland, OH (May 4, 1995).

Lochhead, R. Y.; P. Shannon; "Comparative Coacervation Studies of Poly(Acrylic Acid) and Poly(Etylene-Maleic Anhydride)," SCC Annual Scientific Seminar, Cleveland, OH (May 4, 1995).

Lochhead, R. Y.; S. D. Villafanez; "Phase Behavior of Aqueous Solutions of Sulfonated Poly(styrene-b-hydrogenated butadiene)," SCC Annual Scientific Seminar, Cleveland, OH (May 4, 1995).

Lochhead, R. Y.; C. F. Welch; "Investigations of Bicontinuous Cubic Liquid Crystalline Phases," SCC Annual Scientific Seminar, Cleveland, OH (May 4, 1995).

Lochhead, R. Y.; "Associative Thickeners," in the short course, "Coatings," held with the 22nd Waterborne, Higher-Solids, and Powder Coatings Symposium, New Orleans, LA (February 21, 1995).

Lochhead, R. Y.; "Principles of Adsorption and Colloid Stabilization," in the short course "Watersoluble Polymers," held with the 22nd Waterborne, Higher-Solids, and Powder Coatings Symposium, New Orleans, LA (February 21, 1995).

Lochhead, R. Y.; "Polymeric Emulsifiers," SCC California Chapter, Los Angeles, CA (November 22, 1994).

Lochhead, R. Y.; "Polymeric Emulsifiers," SCC Southeast Chapter, Memphis, TN (November 14, 1994).

Lochhead, R. Y.; "Formulation Principles," SCC Southeast Chapter, Memphis, TN (November 14, 1994).

Lochhead, R. Y.; "Industry/Academiá Interaction," Polymer Science Industrial Advisory Committee, Hattiesburg, MS (October 27-28, 1994).

Lochhead, R. Y.; "Principles of Polymeric Emulsifiers," International Conference on Formulation and the Environment, Biotechnology Center, Research Triangle Park, NC (October 13, 1994).

Lochhead, R. Y.; "Adventures in Surfactants," SCC New York Chapter, NJ (October 5, 1994).

Lochhead, R. Y.; "The Physical Principles of Formulation," SCC Short Course, Chicago, IL (September 28, 1994).

Lochhead, R. Y.; "Polymers and Commerce in Mississippi," Poster Presentation, New South Economic Development Conference, Hattiesburg, MS (September 27, 1994).

Lochhead, R. Y.; "Polymeric Emulsifiers," SCC Southeast Symposium, Memphis, TN (September 24, 1994).

Lochhead, R. Y.; "Polysaccharide Structure and Polymer/Surfactant Interaction," Procter & Gamble Seminar, Hunt Valley, MD (August 25-26, 1994).

Lochhead, R. Y.; P. Shannon; M. Pollard; "An Investigation of Polyelectrolyte/Nonionic Polymer Interactions," American Chemical Society, Polymer Division, Washington, DC (August 23, 1994).

Lochhead, R. Y.; C. J. Rulison; "The Adsorption of Hydrophobically Modified Hydrophilic Polymers at Oil/Water Interfaces," ACS, Colloids Division, Washington, DC (August 23, 1994).

Lochhead, R. Y.; M. E. Tisack; "An Investigation of Plant Oleosins as Polymeric Emulsifiers," ACS, 68th Colloid and Surface Science Symposium, (June 21, 1994).

Lochhead, R. Y.; P. Shannon; M. Pollard; "An Investigation of Polyelectrolytes/Nonionic Polymer Interactions," ACS, 68th Colloid and Surface Science Symposium, (June 20, 1994).

Lochhead, R. Y.; C. J. Rulison; "Adsorption of Hydrophobically Modified Water Soluble Acrylic Acid and Cellulose-Based Polymers at Dynamic Oil/Water Interfaces," ACS, 68th Colloid and Surface Science Symposium, (June 19, 1994).

Lochhead, R. Y.; "Study of the Morphology of Liquid Crystalline Phases Utilizing Long-Chain Fatty Acids," SCC National Scientific Seminar, Las Vegas, NV (May 5, 1994).

Lochhead, R. Y.; R. K. Goundas; "Study of the Morphology of Liquid Crystalline Phases Utilizing Long-Chain Fatty Acids when Complexed with Solvents," SCC National Scientific Seminar, Las Vegas, NV (May 5, 1994).

Lochhead, R. Y.; A. Hossain; "Liquid Crystalline Morphology of Long Chain Fatty Acids Neutralized by Various Amines in Aqueous Solution," SCC National Scientific Seminar, Las Vegas, NV (May 5, 1994).

Lochhead, R. Y.; H. Bui; "An Investigation of the Mechanism of Polymeric Emulsification," SCC National Scientific Seminar, Las Vegas, NV (May 5, 1994).

Lochhead, R. Y.; T. Oki; "Determination of the Amount of Polymer Adsorbed to Oil Droplets in Sterically Stabilized Oil-in-Water Emulsions," SCC National Scientific Seminar, Las Vegas, NV (May 5, 1994).

Lochhead, R. Y.; C. J. Rulison; "The Kinetics of Polymer Diffusion to Liquid/Liquid Interfaces by Drop Volume Techniques," SCC National Scientific Seminar, Las Vegas, NV (May 5, 1994).

Lochhead, R. Y.; P. Shannon; "An Investigation of Polyelectrolyte/Nonionic Polymer and Polyelectrolytes/Polyelectrolytes Interaction," SCC National Scientific Seminar, Las Vegas, NV (May 5, 1994).

Lochhead, R. Y.; C. M. Rodgers; "Evaluation of Critical Overlap Concentration for a Series of Polyelectrolytes," SCC National Scientific Seminar, Las Vegas, NV (May 5, 1994).

Lochhead, R. Y.; M. E. Tisack; "The Study of Proteins from Plants and Insects as Candidates for Oil Recovery," SCC National Scientific Seminar, Las Vegas, NV (May 5, 1994).

Lochhead, R. Y.; J. Medley; "Construction of a High Pressure Fully Automated Reactor Suitable for Critical Fluid Experimentation," SCC National Scientific Seminar, Las Vegas, NV (May 5, 1994).
Lochhead, R. Y.; "The Polymer Science Program at the University of Southern Mississippi," ACS, Rubber Division Conference, Chicago, IL (April 22, 1994).

Lochhead, R. Y.; C. J. Rulison; "An Investigation of Polyelectrolyte/Polyelectrolyte Interaction," 6th S.E. Graduate Conference, Hattiesburg, MS (April 14, 1994).

Lochhead, R. Y.; C. J. Rulison; "The Kinetics of Polymer Diffusion to Liquid/Liquid Interfaces by Drop Volume Techniques," Poster Presentation, 6th S.E. Graduate Conference, Hattiesburg, MS (April 14, 1994).

Lochhead, R. Y.; M. E. Tisack; "An Investigation of Plant Oleosins as Polymeric Emulsifiers," Poster Presentation, 6th S.E. Graduate Conference, Hattiesburg, MS (April 14, 1994).

Lochhead, R. Y.; A. L. Eachus*; "Alkanolamine Neutralizers in Cosmetic Formulation," 4th Joint Australian Cosmetic Congress, (April 10, 1994).

Lochhead, R. Y.; "Industry/University Co-operative R&D," Eastman Chemical, Kingsport, TN (March 24, 1994).

Lochhead, R. Y.; "Construction of a High Pressure Reactor," Dow Chemical, Midland, MI (February 22, 1994).

Lochhead, R. Y.; "Associative Thickeners," in the short course, "Coatings," held with the 21st Waterborne, Higher-Solids, and Powder Coatings Symposium, New Orleans, LA (February 8, 1994).

Lochhead, R. Y.; "Polymers at Interfaces," in the short course, "Watersoluble Polymers," held with the 21st Waterborne, Higher-Solids, and Powder Coatings Symposium, New Orleans, LA (February 8, 1994).

Lochhead, R. Y.; "Polymeric Emulsifiers"; Society of Cosmetic Chemists, Dallas, TX (January 26, 1994).

Lochhead, R. Y.; "Polymeric Emulsifiers," Seminar at Rhone-Poulenc, Corporate R&D, New Jersey (January 14, 1994).

Lochhead, R. Y.; "Natural Protein Emulsifiers from Menhaden"; Gulf Coast Research Laboratory, Ocean Springs, MS (January 11, 1994).

Lochhead, R. Y.; J. Zhou; "The Adsorption of Trimethylammonium Hydroxypropylchitosan on Keratin Fibers," SCC Annual Conference, New York, NY (December 3, 1993).

Lochhead, R. Y.; "Polymeric Emulsifiers", Society of Cosmetic Chemists, Boston, MA (November 18 1993).

Lochhead, R. Y.; The Global Technology and Marketing of Pharmaceutical and Cosmetic Products", United Nations 3-Day Course, Vienna, Austria (November 8-11, 1993).

Lochhead, R. Y.; "Polymers as Hair Fixatives," Society of Cosmetic Chemists, New York, NY (November 3, 1993).

Lochhead, R. Y.; C. J. Rulison; S.D. Cain; "Polymeric Emulsifiers," CTFA Annual Conference, Atlantic City, NJ (November 2, 1993).

Lochhead, R. Y.; "Research Philosophy: Time-to-Market Versus Basic Research for Innovation," Invited Lecture, CTFA Annual Conference, Atlantic City, NJ (November 1, 1993).

Lochhead, R. Y.; "Liquid Crystal Phases in Surfactants and Stratum Corneum," Invited lecture, COSPHA Symposium V, San Antonio, TX (October 7, 1993).

Lochhead, R. Y.; "Introduction to Micelles and Liquid Crystals," SCC Educational Symposium, Chicago, IL (August 27, 1993).

Lochhead, R. Y.; C. J. Rulison; "Investigation of the Mechanism of Emulsification and Associative Thickening by Hydrophobically-Modified Hydroxyethylcellulose and Poly(acrylic acid)," presented at the American Chemical Society National Meeting, Chicago, IL (August 24, 1993).

Lochhead, R. Y.; M. E. Ellis; J. E. Parish; "The Effect of Electrolytes and Cosurfactants on the Phase Behavior and Rheology of Polymer/Surfactant Systems," presented at the American Chemical Society National Meeting, Chicago, IL (August 24, 1993).

Lochhead, R. Y.; C. J. Rulison; "Steric Stabilization and Associative Thickening Mechanism of Polymeric Emulsifiers," Gordon Conference, New Hampshire (June 1993).

Lochhead, R. Y.; C. J. Rulison; P. Higginbotham; C. Fuller; "An Evaluation of Hydrophobically-Modified Hydroxyethylcelluloses as Stabilizers for the Oil/Water Interface," 67th Colloid and Surface Science Symposium of the ACS, Toronto, Canada (June 21-23, 1993).

Lochhead, R. Y.; "Physical Principles of Formulation with Surfactants," Coatings for Formulators Short Course, University of Southern Mississippi, Hattiesburg, MS (June 16, 1993).

Lochhead, R.Y.; "Physical Principles of Formulation with Surfactants," Coatings for Chemists Short Course, University of Southern Mississippi, Hattiesburg, MS (June 9, 1993).

Lochhead, R. Y.; "Hair and Hair Products," Society of Cosmetic Chemists Short Course, Cleveland, OH (May 20, 1993).

Lochhead, R. Y.; "Emulsion Formulation," Society of Cosmetic Chemists Annual Scientific Seminar, Baltimore, MD (May 7, 1993).

Lochhead, R. Y.; P. Shannon; "The Effect of Counterion-Molecular Structure and Binding on the Rheology of Polyelectrolyte Thickeners," National Meeting of Society of Cosmetic Chemists, Baltimore, MD (May 1993).

Lochhead, R. Y.; C. J. Rulison; H. S. Bui; T. D. Pierce; "Investigation of the Mechanism of Emulsification by Hydrophobically Modified Hydrogels: IV—Dilute Systems," presented at the National Meeting of Society of Cosmetic Chemists, Baltimore, MD (May 1993).

Lochhead, R. Y.; C. J. Rulison; P. Higginbotham; C. Fuller; "An Evaluation of Hydrophobically-Modified Hydroxyethyl Celluloses as Stabilizers for the Oil/Water Interface," presented at the National Meeting of Society of Cosmetic Chemists, Baltimore, MD (May 1993).

Lochhead, R. Y.; P. Shannon; "Effect of Counterion-Molecular Structure and Binding on the Rheology of Polyelectrolyte Thickeners," Southeastern Graduate Polymer Conference, Georgia (April 1993).

Lochhead, R. Y.; M. Ellis; J. Parish; "Effect of Electrolytes and Cosurfactants on the Phase Behavior of Hydrophobically Modified Hydroxyethylcellulose with Ammonium Lauryl Sulfate," Southeastern Graduate Polymer Conference, Georgia (April 1993).

Lochhead, R. Y.; C. J. Rulison; H. S. Bui; T. D. Pierce; "Investigation of the Mechanism of Emulsification by Hydrophobically Modified Hydrogels: IV—Dilute Systems," Southeastern Graduate Polymer Conference, Georgia (April 1993).

Lochhead, R. Y.; "The Environmental Electron Microscope as a Tool to Examine Natural Fiber Processing," The Society of Cosmetic Chemists, Cleveland, OH (March 17, 1993).

Lochhead, R. Y.; "Hair and Hair Products," Short Course for Society of Cosmetic Chemists, Piscataway, NJ (March 16, 1993).

Lochhead, R. Y.; "Selection of Associative Thickeners," in the short course "Modern Coatings Technology," held with the 20th Waterborne, Higher-Solids, and Powder Coatings Symposium, New Orleans, LA (February 23, 1993).

Lochhead, R. Y.; "Applications of Water-Soluble and Swellable Polymers/Colloidal Protection, Flocculation, Absorption and Adhesion," in the short course "Water-Soluble Polymers," held with the 20th Waterborne, Higher-Solids, and Powder Coatings Symposium, New Orleans, LA (February 23, 1993).

Lochhead, R. Y.; "Conditioning Shampoos," Invited presentation to the Society of Cosmetic Chemists, Cincinnati, OH (February 17, 1993).

Lochhead, R. Y.; "The Structure and Rheology of Polymer and Surfactant Gels," Procter and Gamble Company, Miami Valley Labs, Cincinnati, Ohio; (February 17, 1993).

Lochhead, R. Y.; "Advances in Water-Soluble Polymers," Helene Curtis Industries, Chicago, Ill.; (February 11, 1993).

Lochhead, R. Y.; "Reducing Fiber Friction," Monsanto Chemical Company, Pensacola, Fla.; (February 2, 1993).

Lochhead, R. Y.; "Phase Diagrams and Formulation," Worldwide Surfactants Council; S.C. Johnson Wax, Inc., Racine, Wis.; (January 26, 1993).

Lochhead, R. Y.; "Advances in Water-Soluble Polymers," Alco Chemical, Chattanooga, TN; (January 21, 1993).

Mathias, L .J.; R. F. Storey; **R. Y. Lochhead**; "Introduction to Polymer Synthesis," Nalco Chemical, Sugarland, TX; (January 18-19, 1993).

Lochhead, R. Y.; "The Physical Principles of Surfactant Science," Helene Curtis Industries, Chicago, Ill.; (January 14, 1993).

Lochhead, R. Y.; "Interpreting Surfactant Phase Diagrams," Monsanto Company, Pensacola, Fla.; (January 8, 1993).

Lochhead, R. Y.; "Wetting, Spreading and Adhesion," DuPont Company, Kingston, N.C.; (January 7, 1993).
Lochhead, R. Y.; "Selection of Associative Thickeners," Modern Coatings Technology, Waterborne Conference, New Orleans, LA; (February 23, 1993).

Lochhead, R. Y.; "Applications of Water-Soluble and Swellable Polymers/Colloidal Protection, Flocculation, Absorption and Adhesion," Water-Soluble Polymers Short Course, Waterborne Symposium; New Orleans, LA; (February 23, 1993).

Lochhead, R. Y.; "The Thermodynamics of Controlled Drug Delivery from Gels," Alcon Laboratories, Fort Worth, TX; (December 17, 1992).

Lochhead, R. Y.; "Polyelectrolyte Gels - Molecular Structure and Properties, V," BF Goodrich, Brecksville, Ohio; (December 14, 1992).

Lochhead, R. Y.; "Polymer/Surfactant Interaction," The Procter and Gamble Company, Miami Valley, Ohio; (December 10, 1992).

Lochhead, R. Y.; "The Physical Principles of Gels and Gelation," Colgate-Palmolive Company, Piscataway, NJ; (December 1, 1992).

Lochhead, R. Y.; "Polymers at Interfaces," National Starch and Chemical Company, (November 19, 1992).

Lochhead, R. Y.; "Polymer Science," 4 Lectures, ACS Heartland Tour to Lincoln and Omaha,Nb; Moorehouse, Mn; and Sioux Falls, SD; (October 21 - 24, 1992).

Lochhead, R. Y.; "Adventures with Surfactants," SCC Short Course, Minneapolis, MN; (October 20, 1992).

Lochhead, R. Y.; "The Academic/Industrial Interface," USM Polymer Science Industrial Advisory Council, (October 15, 1992).

Lochhead, R. Y.; "Polyelectrolyte Gels - Molecular Structure and Properties, IV," BF Goodrich, Brecksville, Ohio; (October 6, 1992).

Lochhead, R. Y.; "Polymer-Surfactant Interaction," S.C. Johnson, Racine, Wisconsin; (October 1, 1992).

Lochhead, R. Y.; 1 Lecture in the Short Course, *Formulating Coatings*, USM; (August 19, 1992).

Lochhead, R. Y.; "Alpha-olefin Emulsions," Ethyl Corporation, Baton Rouge, LA; (August 13, 1992).

Lochhead, R. Y.; Lecture in Short Course, *Coatings Science for Coatings Chemists*, USM; (August 12, 1992).

Lochhead, R. Y.; "Polyelectrolyte Gels - Molecular Structure and Properties, III," BF Goodrich, Brecksville, Ohio; (August 7, 1992).

Lochhead, R. Y.; "Polymers as Hair Fixatives and Cosmetic Delivery Systems," National Starch and Chemical Corporation, Bridgewater, NJ; (August 6, 1992).

Lochhead, R. Y.; "The Effects of the Adsorption of Cationic Surfactants at Keratin Interfaces," Sherex Chemical Company, Dublin, Ohio; (July 2, 1992).

Lochhead, R. Y.; "Polyelectrolyte Gels - Molecular Structure and Properties, **II**," BF Goodrich, Brecksville, Ohio; (July 1, 1992).

Lochhead, R. Y.; "Polymers in Cosmetics," Eastman-Kodak, Kingsport, TN; (June 30, 1992).

Lochhead, R. Y.; "Processing Principles for Surfactant Compositions," S.C. Johnson, Racine, Wisconsin; (June 9, 1992).

Lochhead, R. Y.; "The Effect of Neutralizing Amine Structure on the Properties of Polyelectrolyte Gels," Angus Chemical Company, Chicago, Illinois; (June 8, 1992).

Lochhead, R. Y.; "Micelles, Liquid Crystals, and Emulsions," Monsanto Chemical Company, Pensacola, Florida; (May 27, 1992).

Lochhead, R. Y.; "Amine Neutralizers," SCC National Conference, Atlantic City, NJ; (May 22, 1992).

Lochhead, R. Y.; "Emulsions without Surfactants," SCC National Conference, Atlantic City, NJ; (May 21, 1992).

Lochhead, R. Y.; "Polymer-Surfactant Interaction in Textile Finishing," DuPont Chemical Company, Greenville, NC; (April 16, 1992).

Lochhead, R. Y.; "Polymer Solutions - Physical Principles," Helene Curtis Industries; Chicago, Illinois; (March 26, 1992).

Lochhead, R. Y.; "Polyelectrolyte Gels - Molecular Structure and Properties, **I**," BF Goodrich, Brecksville, Ohio; (March 12, 1992).

Lochhead, R. Y.; "Surfactants, Micelles, Liquid Crystals," SCC, Cleveland, Ohio; (March 11, 1992).

Lochhead, R. Y.; Eachus, A.C; Bremecker, K.D.; "Alternative Neutralizing Amines for Carbomers," InCosmetics Conference, Frankfurt, Germany; (March 5, 1992).

Lochhead, R. Y.; "The Role of Surface-Active Agents and Polymers in Dispersions," Engineering Foundation Conference, Palm Beach, Florida; (March 1992).

Lochhead, R. Y.; "The Role of Surface-Active Agents and Polymers in Coatings," Plenary Lecture, Nineteenth Annual Water-borne Conference, New Orleans, LA; (February 20, 1992).

Lochhead, R. Y.; "Applications of Water-Soluble and Swellable Polymers/Colloidal Protection, Flocculation, Adsorption, and Adhesion," *Water-Soluble Polymers Short Course*, New Orleans, LA; (February 19, 1992).

Lochhead, R. Y.; "Selection of Associative Thickeners," *Modern Coatings Short Course*, New Orleans, LA; (February 19, 1992).

Lochhead, R. Y.; "Principles of Dispersion and Emulsification," Clemson University, Textile Finishing Short Course, (February 12, 1992).

Lochhead, R. Y.; "The Science of Print-Paste Concentrates," Clemson University, Textile Finishing Short Course, (February 12, 1992).

Lochhead, R. Y.; "Introduction to Emulsion Science," Allergen-Herbert Laboratories, Irvine, Ca.; (February 5, 1992).

Lochhead, R. Y.; H. Edelstein; "Hair and Hair Products," SCC Short Course, Los Angeles, Ca.; (February 4, 1992).

Lochhead, R. Y.; "Interfaces, Micelles, and Liquid Crystals," Worldwide Surfactants Council, S.C. Johnson Wax, Racine, Wisconsin; (January 16, 1992).

Lochhead, R. Y.; "Case Studies in Innovation: Introducing New Materials to the Cosmetics Industry," Ajinomoto Company, Kawasaki, Japan, (October 30, 2000). **Invited Lecture**

TEACHING

1. Courses Taught

Fall, 1990;
PSC 401, 'Physical Chemistry of Polymers",

Spring, 1991;
PSC 402, Physical Chemistry of Polymers",

Summer, 1991;
PSC 791,
PSC 691,

Fall, 1991;
PSC 401, Physical Chemistry of Polymers",

Spring 1992,
PSC 711, 'Physical Chemistry of Polymers"
PSC 791, , Research
PSC 691, Research

Summer 1992,
PSC 791, , (Research)
PSC 691, , (Research)

Fall 1992,
PSC 401, Physical Chemistry of Polymers",
PSC 410, Lab Safety
PSC 691, (Research)

PSC 791, (Research)

Spring 1993,
PSC 402, Physical Chemistry of Polymers",
PSC 691, (Research)
PSC 791, (Research)

Summer 1993,
PSC 791, (Research)
PSC 691, (Research)

Fall 1993,
PSC 410, Lab Safety
PSC 691, (Research)
PSC 791, (Research)

Spring 1994,
PSC 791, (Research)
PSC 711, "Physical Chemistry of Polymers",
PSC 691, (Research)
PSC 491, (Research)

Summer 1994,
PSC 791, (Research)
PSC 691, (Research)
PSC 898, (Thesis),

Fall, 1994;
PSC 791, (Research)
PSC 691, (Research)
PSC 898, (Thesis),
PSC 401, Physical Chemistry of Polymers",

Spring 1995,
PSC 490/491, (Research)
PSC 691, (Research)
PSC 791, (Research)

Summer 1995,
PSC 791, (Research)

Fall 1995,
PSC 720, (Techniques Lab),
PSC 341L, (Techniques Lab),
PSC 791, (Research)
PSC 691, (Research)

Spring 1996,
PSC 342L, (Techniques Lab),
PSC 402, "Physical Chemistry of Polymers",

PSC 721, (Techniques Lab),
PSC 691, (Research),
PSC 791, (Research),
PSC 898, (Thesis),

Summer 1996,
PSC 691, (Research
PSC 791, (Research),
PSC 698, (Thesis),
PSC 898, (Thesis),

Fall 1996,
PSC 390, (Research)
PSC 720, (Techniques Lab),
PSC 341L, (Techniques Lab),
PSC 691, (Research),
PSC 698, (Thesis),
PSC 791, (Research),
PSC 898, (Thesis),
HONS 403, 'Organizing for Innovation – Case Histories"

Spring 1997,
PSC 342L, (Techniques Lab),
PSC 390, (Research),
PSC 691, (Research),
PSC 711, "Physical Chemistry of Polymers",
PSC 721, (Techniques Lab),
PSC 791, (Research),
PSC 898, (Thesis),

Summer 1997,
PSC 410, (Lab Safety)
PSC 490, (Research),
PSC 490L, (Research),
PSC 691, (Research),
PSC 791, (Research),
PSC 898, (Thesis),

Fall 1997,
PSC 341L, (Techniques Lab),
PSC 390, (Research),
PSC 720, (Techniques Lab),
PSC 698, (Thesis)
PSC 791, (Research),
PSC 898, (Thesis),

Spring 1998,
PSC 342L, (Techniques Lab),
PSC 390, (Research),
PSC 492, (Research)
PSC 711, "Physical Chemistry of Polymers",
PSC 721, (Techniques Lab),

PSC 791, (Research),

Summer 1998
PSC 691, (Research),
PSC 791, (Research),

Fall 1998
PSC 691, (Research),
PSC 791, (Research),
PSC 898, (Thesis),

Spring 1999
PSC 390, (Research),
PSC 492, (Research),
PSC 691, (Research),
PSC 791, (Research),
PSC 898, (Thesis),
PSC 691, (Research),

Summer 1999
PSC 691, (Research),
PSC 791, (Research),
PSC 880, Advanced Surface and Colloid Science,
PSC 898, (Thesis),

Fall 1999
PSC 691, (Research),
PSC 791, (Research),
PSC 898, (Thesis),

Spring 2000
PSC 390, (Research),
PSC 691, (Research),
PSC 698, (Thesis),
PSC 711, "Physical Chemistry of Polymers",
PSC 791, (Research),
PSC 898, (Thesis),

Summer 2000
PSC 691, (Research),
PSC 898, (Thesis),

Fall 2000
PSC 341L, (Techniques Lab),
PSC 691, (Research),
PSC 698, (Thesis),
PSC 720, (Polymer Techniques I),

Spring 2001
PSC 342L, (Techniques Lab),
PSC 390, (Individual Research Projects),
PSC 402, (Polymer Physical Chemistry),
PSC 691, (Research),

PSC 698, (Thesis),
PSC 721, (Techniques Lab)
PSC 791, (Research),

Summer 2001
PSC 691 (Research),
PSC 791, (Research),

Fall 2001
PSC 691, (Research),
PSC 789, (Seminar),
PSC 791, (Research),.,
CHE 390, (individual Research),

Spring 2002
CHE 490 (Hons Research)
PSC 691, (Research),
PSC 791, (Research),.,
CHE 390, (individual Research),
PSC 402, Polymer Physical Chemistry,
PSC 698, (Thesis),
PSC 898 (Thesis),

Summer 2002
PSC 791, (Research),
PSC 698, (Thesis),
PSC 898 (Thesis),

Fall 2002
CHE 491 (Hons Research)
PSC 691 (Research),
PSC 697 (Independent Study and Research),
PSC 791, (Research),
PSC 698, (Thesis),
PSC 898 (Thesis),

Summer 2003
PSC 691, (Research),
PSC 791, (Research),

Fall 2003
PSC 401 (Polymer P. Chem)
PSC 691 (Research),
PSC 791, (Research),

Spring 2004
PSC 402 (Polymer P. Chem)
PSC 691, (Research),
PSC 791, (Research),.,

Summer 2004
PSC 691, (Research),
PSC 791, (Research),

Fall 2004
PSC 490/491 (Polymer Capstone Course)
PSC 880 (Polymer Colloid & Surface Science)
PSC 691 (Research),
PSC 791, (Research),

Spring 2005
PSC 402 (Polymer P. Chem)
PSC 691, (Research),
PSC 791, (Research),.,

Summer 2005
PSC 691, (Research),
PSC 791, (Research),

Fall 2005
PSC 490/491 (Polymer Capstone Course)
PSC 691 (Research),
PSC 791, (Research),

Spring 2006
PSC 402 (Polymer P. Chem)
PSC 691, (Research),
PSC 791, (Research),.

Summer 2006
PSC 691, (Research),
PSC 791, (Research),

Fall 2006.
PSC 490/491 (Polymer Capstone Course)
PSC 191 (Introduction to Polymers)
PSC 691 (Research),
PSC 791, (Research)

Course Evaluations

Lochhead, Robert Y.: student course evaluations on record in the department files, good solid evaluations.

Graduate Students Directed

Kuk-Wa Chu, advisor, MS, (U. of Cincinnati), 1990.
Chris Rulison, advisor, Ph.D. 1995
Porter Shannon, advisor, PhD. 1997
Monica Tisack-Kathman, advisor, Ph.D. 1998
Stacey Villafanez-Maggio, advisor, Ph.D. 1999
Cheri McConnell-Boykin, advisor, Ph.D. 1999
Cynthia Welch, advisor, MS, 1999
Tonya McKay, advisor, MS, 2000
Joan Schuman, advisor, Ph.D. 2003
Jennifer Smith, MS 2000
Jason Powers, MS advisor

Camille Haynes, advisor, Ph.D.2003
Stephen Jones, Ph.D. advisor
Lisa Huisinga, Ph.D. advisor
Virginia Smith, MS. advisor
Andrew Magenau, Ph.D. advisor
Adarsh Maini; Research advisor
Sushila;
Manju ;
Keerti Kanderwal
Pradeep

Yihua Chang, PhD, committee member
James Dickerson, PhD, committee member
Steve Ezzell, PhD, committee member
Kelly Branham, PhD, committee member
Brett Chisholm, PhD, committee member
Stephen Warren, PhD, committee member
Ken Malone, PhD, committee member
Veronica Reichert, PhD, committee member
Robert Thompson, PhD, committee member
John Randy Wright, PhD, committee member
David Squire, PhD, committee member
Shunlua Shu, PhD, committee member
Erich Kathmann, PhD, committee member
Edguardo Anzures, PhD, committee member
Chase Boudreaux, PhD, committee member
Amy Taylor, PhD, committee member
Kelly Shoemake, PhD, committee member
Daniel Baugh, PhD, committee member
James Rawlins, committee member
Sandra Young, committee member
Raghuram Gummarju. committee member
Martin E. Cowan, committee member
Forrest Landis, committee member
Christopher Cypcar, committee member
Jianbin Xue, committee member
Wassana Apichatachutapan, committee member
Timothy Boykin, committee member
Elizabeth Brister, committee member
Corey King, committee member
Melissa Manuszak, committee member LSU
David Suizdak, committee member
Scott Steadman, committee member
Nick Weigel, committee member
Leslie White, committee member
Scott Armentrout, committee member
Shan Clark, committee member
Michael Donovan, committee member
Kathryn Johnson, committee member
Corey King, committee member
Mark Michalovic, committee member
David Mountz, committee member

Grant Barber, committee member
Gregory Booth, committee member
Christopher Lester, committee member
Bo Pan, committee member
Dennis Parrish, committee member
Garrett Poe, committee member
Michael Richardson, committee member
Paul Start, committee member
David Thomas, committee member
Amy Marks, committee member - USM Biology and FDA.
Brent Sumerlin, committee member.
Adam Scheuer, Committee Member
Alicyn Hayney, Committee Member
Gregory Brust, Committee Member
Jamie Messman, Committee Member
Sean McConaughy,Committee Mamber
Gilles Divoux,Committee Member,
Adam Lamont,Committee Member
Stacey Trey,Committee Member,
Alicyn Haney,Committee Member

Undergraduate Research Directed

Spring 1991

Chad Edwards;	Polymer/Surfactant Interaction
Robert Hathorne;	Polyelectrolyte Adsorption
Travis Jones;	Polymer/Surfactant Interaction

Fall 1991 & Spring 92

Wolfe, P.S.;	"Polymer-Surfactant Interaction in an Uncharged Polysaccharide-Ammonium Lauryl Sulfate System."
Parish, J.G.;	"Study of the Interaction of an Anionic Surfactant with a Cellulosic Associative Thickener."
Brooks, G.A.;	"Investigation of the Interaction Between a Cationically-Charged Hydrophobically-Modified Hydroxyethyl Cellulose."
Wissner, A.;	"Effect of Strong Bases on Human Hair."
Lindsey, D.M.;	"Polymer-Surfactant Interactions in Potential Bioadhesive Systems."
Powell, M.;	"Investigation of the Effect of the Molecular Structure of Organic Amine Neutralizing Bases on Poly(acrylic acid) Ion Expansion in Aqueous Solution."

Brown, R.;	"Evaluation and Selection of Neutralizers for Poly(acrylic acid) Thickeners."
Cooley, G.E.;	"Evaluation of Alternative Neutralizing Bases for Carbomers: The Effect of Neutral, Ionically-Dissociated Salt."
Gay, K.M.;	"Investigation of the Molecular Adsorption of Surfactant and Hydrophilic Polymer Aqueous Solutions on Glass and Keratin."
Kwan, K.S.;	"Investigating the Use of a Polymeric Emulsifier to Prepare New Low Volatile Organics Aqueous Coatings."
Edwards, C.F.;	"Identifying the Interactions Between Sodium Dodecyl Sulfate and Hydroxypropylcellulose."
Fron, W.R.;	"An Investigation of the Effect of the Molecular Structure of Neutralizing Amine on the Efficacy of Carbomers as a Gellant for Hydroalcoholic Systems."
Watson, M.;	"Interaction Between Hydroxyethylcellulose and Ammonium Lauryl Sulfate."
West, R.;	"Alternative Amines for Carbopol."

<u>Summer 1992</u>

Bui, H.S.;	"Polymer Adhesion at Liquid-Liquid Interface."
Armstrong, K.;	"ALS-CTAC."
Wolfe, S.;	"ALES/HMHEC."
Dodd, D.;	"ALES/HMHEC."
Watson, M.;	"TEA Palmitate."
Hossain, A.;	"TEA Palmitate."
Nguyen, T.;	"TEA Palmitate."
Pierce, T.;	"ALS/ALES."
Phillips, D.;	"Alternative Amines for Carbomer."
Light, K.;	"Alternative Amines for Carbomer."
Bridges, C.;	"Alternative Amines for Carbomer."
Medley, J.;	"Alternative Amines for Carbomer."

Higginbotham, P.;	NSF REU student
Fuller, C;	NSF REU student
West, R.;	"Alternative Amines for Carbomer."

Fall 92

Bui, H.S.;	"Polymeric Emulsifiers."
Struss, B.;	"Polymeric Emulsifiers."
West, R.;	"HMHEC & Nonionics."
Powell, M.;	"Polymer/Clay Interaction."
Watson, M.;	"Spatterguard Analysis."
Armstrong, K.;	"Cationic Surfactant/Polymer."
Nguyen, T.;	"Alphastep & Glucose Esters with HMHEC."
Medley, J.;	"Counterion Binding."
Phillips, D.;	"Hydrotrope/Counterion Distribution."
Pierce, T.;	"Polyelectrolyte Characterization."
Rodgers, C.;	"Polyelectrolyte Characterization."
Light, K.;	"Evaluation of Alternative Neutralizers for Carbomer."
Hossain, A.;	"Evaluation of Alternative Neutralizers for Carbomer."
Bridges, C.;	"Evaluation of Alternative Neutralizers for Carbomer."
Cunningham, S.;	"Evaluation of Alternative Neutralizers for Carbomer."
Fron, W.;	"Counterion Binding."

Spring 1993

Bui, H.S.;	"Dynamics of the adsorption of hydrophobically-modified poly(acrylic acid) of oil-water interfaces."

Struss, W.;	"Design of a drop-volume apparatus to measure kinetics of polymer adsorption."
West, R.;	"Interaction of hydrophobically-modified hydroxyethylcellulose with lyotropic liquid crystals."
Hossain, A.;	"Phase diagrams of oil-water systems in the presence of polymeric emulsifiers."
Armstrong, K.;	"Investigation of the interaction of hydrophobically-modified hydroxyethylcellulose with ammonium lauryl ether sulfate."
Nguyen, T.;	"Investigation of the interaction of hydrophobically-modified hydroxyethylcellulose with alkyl polyglycerides."
Light, K.;	"Phase diagrams of the system 2-amino-2-methylpropanol, palmitic acid, water."
Phillips, D.;	"A study of the hydrotrope effect of 2-amino-2-methyl-propanol in linear alkylbenzene sulfonate."
Gates, A.;	"An investigation of the phase of the system Poly(acrylic acid) and ammonium lauryl sulfate."
Bridges, C.;	"An investigation of the phase-behavior of the system N, N, N^1, N^1 tetrahydrocypropyl ethylenediamine/palmitic acid/water."
Medley, J.;	"Polymer Gel Rheology."
Fron, W.;	"Literature Survey and Review of Cosmetic Polymers."
Pierce, T.D.;	"Molecular Characterization of cross-linked poly(acrylic acid) microgels."
Rogers, C.;	"Viscosity characterization of poly(acrylic acid) microgels."

Summer 1993

Welch, C.;	"A study of the rheology of polymer/surfactant gels; hydrophobically modified hydroxyethylcellulose and ammonium lauryl sulfate."
Armstrong, K.;	"The phase-behavior of spin-finishes."
Bridges, C.;	"Mesomorphic phase behavior of palmitic acid; amino-methylpropane and water."

	West, R.;	"Mesomorphic phase behavior of oleic acid, amino-methylpropane and water."
	Goundas, K.;	"Mesomorphic phase behavior of oleic acid, N,N N', N' tetrahydroxypropyl ethylene diamine and water."
	Hossain, A.;	"Mesomorphic phase behavior of oleic acid, triethanolamine and water."
	Medley, J.;	"Construction of a high-pressure reactor for the polymerization of ethylene under supercritical conditions."
	Cain, S;	NSF REU student
	Thorton, K.;	NSF REU student
	Walker, K.;	NSF REU student
1994	Cole, M,	NSF REU student from Georgia Tech
	King, C	NSF REU student from Tulane University
1995	Lamonte, J.	"Polymeric surfactants"
	Rediske, J.	"Lyotropic Liquid Crystals"
	Robbins, E.	"Hydrophobically-modified Starch"
	Sanford, W.	"Menhaden Protein"
	Craig, Sean	REU student from St. Norberts, WI
	Donovan, M.	REU student from St. Norberts, WI
1996	Montes de Oca, M.	"Polymer adsorption on montmorillonite"
	Lamonte, J.	"Polymeric Surfactants"
	Robbins, E.	"Hydrophobically-modified Starch"
	Sanford, W.	"Menhaden Protein"
1997	Clifton, William	"Polymer adsorption"
	Montes de Oca, M.	'Polymer adsorption"
	Dorman, D.	"Hydrophobically-modified polysaccharides"
	Fye, F.	NSF REU student
	Hunt, D.	"Phase Diagrams"
	Johnson, Ah Tuan	"Polymer Adsorption"
	La Monte, J.	"Polymeric Surfactants"
	Marks, A.	"Polymer Adsorption"
	Robbins, E.	"Hydrophobocally-modified Starch"
	Sanford, W.	"Menhaden Protein"
1998	Boudreaux, R.	"Phase Diagrams"
	Dorman, D.	"Hydrophobically-modified Polysaccharides"
	Hunt, D.	"Phase Diagrams"
	Marks, A.	"Polymer Adsorption"
	Preskin, D.	"Rheology of surfactant phases"

1999	Boudreaux, R.	"Phase Diagrams"
	Dorman, D.	"Hydrophobically-modified Polysaccharides"
	Marks, A.	"Polymer Adsorption"
	Preskin, D.	"Rheology of surfactant phases"
2000	Ali, M.	"Polymeric Micelles"
	Boudreaux, R.	"Polymeric Micelles"
	DeLaine, Arvelle	"Polymeric Micelles"
	Dorman, D.	"Hydrophobically-modified polysaccharides"
	Kolibal, L.	"Polymeric Micelles"
	Murray, C.	"Polymeric Micelles"
	Presken, D.	"Polymeric Micelles"
	Shaw, J.	"Polymeric Micelles"
	Watson, N.	"Phase Diagrams"
	Thomas, R.	NSF REU Student
2001	DeLaine, Arvelle	"Polymeric Micelles"
	Kolibal, L.	"Hydrophobic Modification of Hydrophilic Polymer"
	Urban, A.	"Adsorption of polymers on Montmorillonite"
2002	DeLaine, Arvelle	"Polymeric Micelles"
	Kolibal, L.	"Hydrophobic Modification of Hydrophilic Polymer"
	Urban, A.	"Adsorption of Polymers on Montmorillonite"
	Gallender, S.	"Emulsion droplet/particle interaction"
	Decker, J.	NSF REU Student from Steven's Point Wisconsin
2003	DeLaine, Arvelle	Biodegradable Nanocomposites
	Wills, Jamesha	Hydrophobic Modification of Hydrophilic Polymer
	Edwards, Christina	Polymer-Surfactant Interaction
2004	Edwards, Christina	Polymer-Surfactant Interaction
	Cole, Marsha	Clay. Polymer Interaction
	Cox, Ashley	Wetting of Aluminum Stearate
	Goodman, Lauren	Polymer-surfactant Interaction
	Follett, Nathan	Polymer polyphenol coacervates
2005	Edwards, Christina	Polymer-Surfactant Interaction
	Cox, Ashley	Polymer nanocomposites
	Goodman, Lauren	Polymer-surfactant Interaction
	Tara Waller	Polymer-surfactant Interaction
2006	Edwards, Christina	Polymer-Surfactant Interaction
	Cox, Ashley	Polymer Coacervates
	Goodman, Lauren	Polymer-Rheology
	Tara Waller	Polymer-surfactant Interaction
	Emily Hoff	Polymer-surfactant Interaction

Summary of External Research Funding of R. Y. Lochhead, 1991 - Present

Project	Source	Award
Polymer/Surfactant Coacervates -Structure Building	S.C. Johnson & Sons, Inc.	$49,000
Evaluation of a New Associative Thickener	S.C. Johnson & Sons, Inc.	$3496
Investigation of the Mechanism and Molecular Structure/Property Relationships Involved in Polymeric Emulsification	SC Johnson Wax	$10,000
The Study of Structure-Building by Polymer/Surfactant Coacervates II	SC Johnson & Son, Inc	$27,017
The Study of Structure-Building by Polymer/Surfactant Coacervates III	SC Johnson & Son, Inc.	$19,171
The Study of Structure-Building by Polymer/Surfactant Coacervates IV-A	SC Johnson & Son, Inc	$9,802
The Study of Structure-Building by Polymer/Surfactant Coacervates IV-B	SC Johnson & Son, Inc.	$44,905
Develop a Fundamental Understanding of Carbopol Resins	BF Goodrich	$50,000
Study of the Synergistic Structuring of Smectite Clays with Water-Soluble Polymers	Southern Clay Products	$6,219
The Role of Hydroxypropylchitosan in Hair Products	Amway Corporation	$4,855
The Role of Alkanolomines as Hydrotropes in Detergent Formulation	Angus Chemical	$15,410
Copolymerization of Ethylene with Acid Anhydrides	Dow Chemical Company	$84,053
Polymer/Surfactant Coacervates	S.C. Johnson Wax, Inc .	$43,500
Development of a Macromolecular Emulsifier	Mississippi-Alabama Seagrant Consortium	$196,980 (over 3 years)
Polymerizations in Microgravity (with L.J.Mathias and J. Pojman)	NASA	$135,402/3 = $45,134
Investigation of the Mechanism and Molecular Structure/Property Relationships Involved in Polymeric Emulsification II	SC Johnson Wax	$10,000.
Ethylene Copolymers	Dow Chemical	$47,954

Surfactant coacervates	S.C. Johnson	$10,000
Novel Surfactants	S.C. Johnson	$59,775
Hydrophobically modified polysaccharides	Alcon Labs	$41,579
Starch emulsifiers	National Starch	$20,763
Surfactant coacervates	SC Johnson	$15,000
Soy protein emulsifier	American Soybean Association	$74,291
Research Service	Research Services	$22,185
Fellowship	Phillips Petroleum	$9,000
Starch emulsifiers 1	National Starch	$22,000
Research Service	Research Services	$41,379
Plant oleosins	SCC	$20,000
Fellowship	Troy Chemical	$1,000
Res services	Research Services	$17,500
Scholarship	Paxon	$3,000
Mississippi Pilot extension service	NIST	$316,828
Polyelectrolyte/surfactant interaction	SCC	$20,000
Casein Adsorption	Exxon	$9,000
Fellowship	SPE Fellowship	$5,000
Plant oleosins	SCC	$20,000
Hydrophobically -modified Polysaccharides	NASA	$22,000
Mississippi Pilot extension service	NIST	$523,221
Clay structure	Southern Clay Prod	$10,000
Scholarship	Valspar	$2,500
Mississippi Pilot extension service	NIST	$523,221
Fellowship	Troy Chemical	$1,000
Polyelectrolyte/surfactant interaction	SCC	$20,000
Fellowship	GE	$14,000
Air Quality	Unilever	$75,469
Grant	Eastman	$800
Fellowship	SPE Fellowship	$2,000
Fellowship	Valspar	$2,500
Scholarship	McWhorter	$2,000
Clay structure	Southern Clay Prod	$15,000
Fellowship	Valspar	$2,500
Nanocomposites	DARPA	$247000
Major Instrumentation Grant – NMR upgrade	NSF	$1.2 million

"Mississippi Polymer Institute,"	Department of Commerce,	$606,239 (April 2000),
"The Development of Polymers",	Unilever PLC,	$59332, July 2001
"IPA for Beverly Bradley",	Naval Oceanographic Office,	$158,454, July 2001
"IPA for Eigoro Hashimoto",	Naval Oceanographic Office,	$185,894, July 2001
"Environmentally Compliant Coatings".	Office of Naval Research,	$480,833, Sept 2001.
"High Performance Visualization Center Initiative"".	Naval Oceanographic Office,	$126,000
"Biodegradable Ionomers and Composites".	Office of Naval Research,	$250,000, Nov 2001.
"Distinguished Polymer Lecture Series,"	Bayer Corporation,	$10,000 (April 2001)
"Investigation of Macromolecular Intrusion	Society of Cosmetic Chemists	$20,000, (March 2001)

into Constrained Spaces,"		
"IPA for Beverly Bradley",	Naval Oceanographic Office,	$158,454, July 2001
"Partnership for Innovation,"	National Science Foundation,	$600,000 (July 2001)
'Investigation of Macromolecular Intrusion into Constrained Spaces,"	Society of Cosmetic Chemists	$20,000, (June 2002)
Unrestricted Funds,"	The Procter & Gamble Company,	$10,000 (June 2002)
Partnerships for Innovation in High Throughput Screening	National Science Foundation	$600,000 (Sept. 2002)
Biodegradable Nanocomposites	Office of Naval Research,	$250,000, (2003.
Cationic Cellulose Screening	The Procter & Gamble Company,	$96,000 (2003)
Biodegradable and Digestible Nanocomposite Stretch Wraps for Ecologically-Acceptable Marine Disposal.	Office of Naval Research	$140,000 (2004)
Polymer-surfactant coacervates	Society of Cosmetic Chemists	$20,000, (2004)
Polymer-surfactant coacervates	Society of Cosmetic Chemists	$20,000, (2005)
Biodegradable and Digestible Nanocomposite Stretch Wraps for Ecologically-Acceptable Marine Disposal.	Office of Naval Research	$169,000 (2005)
Polymer- surfactant interactions	Johnson & Johnson	$30,000 (2005)
Polymer – clay interactions	Southern Clay Products	$30,000 (2005)
Polymer 'Lab-on a-chip'	Department of Commerce, NIST	$575,000 (2005)
Combinatorial Methods	Procter & Gamble	$6,127 (2006)
Polymer- surfactant interactions	Johnson & Johnson	$30,000 (2006)
Polymer-Surfactant Interactions	DSM	$130,000 (2006)
Polymer- surfactant interactions	Johnson & Johnson	$30,000 (2006)
Polymer Rheology	Procter & Gamble	$30,000 (2006)
Polymer Rheology	Rohm & Haas	$30,000 (2006)
Polymer characterization	Solutia	$11,000 (2006)
Stumuli responsive systems	Kimberly Clark	$23,000 (2007)
Polymer-surfactant Interactions	DSM	$80,000 (2007)
Dispersion Rheology	Glaxo Smith Kline	$100,000 (2007)

Consulting –last 4 years

Time Frame	Company	Subject
2003 – present time	Procter & Gamble	Water Soluble Polymers
		Rheology Modifiers
		Emulsions
		Polymer-surfactant interaction
		Babycare
		Superabsorbent materials
		Haircare
		Skincare
		Shaving products
		Dental Products
2003	Revlon Consumer Products	Color Cosmetics
2003	Clariant Corporation	Polymers
2003	Welch, Spell, Reemsnyder	Review IP
2003 - present	Finnegan, Henderson, Farabow, Garrett & Dunner,	Hair Coloring, Color Cosmetics
2003-2006	Unilever	Fabric Care
2003	Wrigley	Chewing Gum
2003 - 2007	Oblon, Spivak, McLelland, Maier & Neustadt	Cleansing Products and Skin Lotions
2003	Paragon, Philadelphia	Polymers
2004-present time	Southern Clay Products	Clay-Polymer inteaction
2004 – present time	Ciba Specialty Chemicals Corporation	Polymers
2004-2007	Velocys, Columbus	Emulsions
2004 – present time	Noveon, Cleveland	Polymers
2004 -2005	Schering Plough	Sunscreens
2004	Department of Energy	Committee of Visitors
2004 - 2005	Woodcock Washburn LLP	Denture Adhesives
2004 – present time	Johnson & Johnson	Polymers
2005 – present time	Rohm & Haas	Polymers

2005 – present time	DSM, Geleen, Netherlands	Polymer-surfactant interaction
2006 – present time	National Starch Corporation	Polymers
2006 –present time	Frommer, Lawrence and Haug	Polymers and emulsions
2006- Present Time	McDonnell, Boehnen, Hulbert & Bergham	Expert Witness
2007	Go Jo Industries	Hand Sanitizers
2007	Quin, Emmanuel	Physical Chemistry
2007	Solutia	Polymers
2007	Glaxo Smith Kline	Polymers
2007	Lubrizol	Polymers
2007	Eastman Chemical Company	Polymers
2007	Ward Olivo	Personal Care
2007	Louis Paul	Cosmetics/Personal Care
2007	Seppic Corporation	Polymers
2007	Huntsman Corporation	Polymers
2007	Thermfos	Polymers